DOCUMENT RESUME

ED 194 061 IR 008 914

AUTHOR Simonson, Michael R., Ed.: Rohner, Daniel, Ed.

TITLE Proceedings of Selected Research Paper Presentations at the 1980 Convention of the Association for Educational Communications and Technology and Sponsored by the Research and Theory Division (Denver, CO, April 21-24, 1980).

PUB DATE Apr 80

NOTE 694p.: Legibility varies.

EDRS PRICE MF04/PC28 Plus Postage.

DESCRIPTORS Algorithms: *Audiovisual Communications: Bibliographies: Diagrams: *Educational Research: *Educational Technology: Evaluation: *Instructional Development: Learning Theories: Research Reports: Tables (Data): Task Analysis: *Visual Learning

IDENTIFIERS Association for Educational Communications Tech

ABSTRACT

The 31 papers in this collection represent approximately 35 percent of the manuscripts which were submitted for consideration to the Research and Theory Division of the Association for Educational Communications and Technology (AECT) for presentation at the 1980 AECT convention. All papers were subjected to a blind reviewing process and the ones finally selected represent some of the most current thinking in educational communications and technology. A listing of selected titles indicates the scope of the research paper presentations: "The Cognitive Effect in Bilingual Learners Given Different Pictorial Elaboration and Memory Tasks," "The Relationship of Communication Apprehension Level and Media Competency," "Implications of a Gestalt Approach to Research in Visual Communications," "Research on Pictures and Instructional Texts: Difficulties and Directions," "Imagery--A Return to Empirical Investigation," "A Meta-Analytic Study of Pictorial Stimulus Complexity," "Learner Interest and Instructional Design: A Conceptual Model," "The Organizing Function of Behavioral Objectives," and "Algorithmic Training for a Complex Perceptual-Motor Task." (LLS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED194061

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

PROCEEDINGS OF SELECTED RESEARCH PAPER PRESENTATIONS

at the 1980 Convention of the
Association for Educational Communications and Technology
and sponsored by the
Research and Theory Division
April, 1980 in Denver, Colorado

Edited by:

Michael R. Simonson
Associate Professor of Secondary Education
and
Daniel Rohner
Teaching Assistant

College of Education
Iowa State University
321 Curtiss Hall
Ames, Iowa 50011

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Michael Simonson

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

IR008914

PREFACE

For the second year the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is publishing these Proceedings. Papers published in this volume were presented at the national AECT Convention in Denver, Colorado. A limited quantity of this volume were printed in hard copy and sold. It is also available on microfiche through the Educational Resources Information Clearinghouse (ERIC) system.

REFEREEING PROCESS: All Research and Theory Division papers selected for presentation at the AECT Convention and included in this Proceedings were subjected to a rigorous blind reviewing process. Proposals were submitted to Dr. Louis Berry of the University of Pittsburgh who coordinated the review process. All references to author were removed from proposals before they were submitted to referees for review. Approximately thirty five percent of the manuscripts submitted for consideration were selected for presentation at the Convention and for publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

M.R.S.
Research and Theory Division

REVIEW BOARD

Louis Berry
Coordinator of Review
University of Pittsburgh

William Winn
University of Calgary

John Keller
Syracuse University

Barbara Grabowski
University of Maryland

Francis Dwyer
Penn State University

Perrin Parkhurst
Michigan State University

Michael Simonson
Iowa State University

Carol Carrier
University of Minnesota

Alan Chute
University of South Dakota

Tilman Ragan
University of Oklahoma

Richard Lamberski
Boston University

Dennis Sheriff
Northern Illinois University

William Holiday
University of Calgary

1980 BOARD OF DIRECTORS

RESEARCH AND THEORY DIVISION

OF THE

ASSOCIATION FOR EDUCATIONAL COMMUNICATION AND TECHNOLOGY

William Winn, President 1979-80
Department of Curriculum and
Instruction
University of Calgary
CANADA T2N 1N4

William Daehling, President 1980-81
Lewis and Clark State College
8th Avenue & 6th Street
Lewiston, ID 83501

Perrin Parkhurst, President 1981-82
C.O.M., Dean's Office
A-336 E. Fee Hall
Michigan State University
East Lansing, MI 48824

Tillman Ragan 1978-81
College of Education
University of Oklahoma
Norman, Oklahoma 73066

John Keller 1978-81
Instructional Technology
School of Education
Syracuse University
Syracuse, N.Y. 13210

Louis Berry 1980-83
Educational Communications and
Technology
103 LIS Building
University of Pittsburgh
Pittsburgh, PA 15260

Michael Simonson 1978-81
321 Curtiss Hall
College of Education
Iowa State University
Ames, Iowa 50011

Carol Carrier 1979-82
250 Burton Hall
178 Pillsbury Dr., S.E.
University of Minnesota
Minneapolis, MN 55455

Alan Chute 1980-83
University of South Dakota
School of Medicine
2501 West 22nd
Sioux Falls, South Dakota

Thomas Nielson 1978-81
Southeastern RMEC
1717 11th Avenue S.
Birmingham, AL 35205

Barbara Grabowski 1980-83
334A MSTF
10 South Pine
University of Maryland
School of Medicine
Office of Medical Education
Baltimore, MD 21201

Frank Dwyer, Newsletter Editor
Mitchell Building
The Pennsylvania State University
University Park, PA 16802

TABLE OF CONTENTS

Page

The Cognitive Effect in Bilingual Learners Given Different Pictorial Elaboration and Memory Tasks
by Carlos Acevedo and Richard Lamberski ---------------------------------- 1

The Relationship of Communication Apprehension Level and Media Competency
by Cheryl Anderson -- 35

Implications of a Gestalt Approach to Research in Visual Communications
by Ann Becker -- 55

Research on Pictures and Instructional Texts: Difficulties and Directions
by Philip Brody -- 70

The Effects of Three Levels of Visual Complexity on the Information Processing of Field-Dependents and Field-Independents when Acquiring Instructional Information for Performance on Three Types of Educational Objectives
by James Canelos --- 85

Imagery--A Return to Empirical Investigation
by Judy Chiswell and Richard Lamberski -------------------------------- 98

A Meta-Analytic Study of Pictorial Stimulus Complexity
by Francis Clark and Jay Angert -------------------------------------- 125

Learner Interest and Instructional Design: A Conceptual Model
by Bernard Dodge --- 166

The Organizing Function of Behavioral Objectives
by Wendy Dunn and Barry Bratton -------------------------------------- 190

Attention to Instructional Media: What are the Relevant Media Techniques and Learner Characteristics?
by Malcolm Fleming, W. Howard Levie, and James McLeskey --------------- 201

Algorithmic Training for a Complex Perceptual-Motor Task
by Vern Gerlach and Richard Schmid ----------------------------------- 217

The Systematic Design of a Persuasive Communication for Changing Attitudes of Preservice Teachers Toward Science
by Barbara Grabowski, Paul Welliver, and Robert Shrigley -------------- 220

Systematized Feedback and Mathematics Performance
by Michael Hannafin --- 244

Visual Perception in Language Learning: A Developmental Perspective with Implications for Second Language Learning and Research
by Roseanne Harrison and David Rickard -------------------------------- 262

Page

The Effectiveness of Elaborate Visual Cueing and Reduced Step Size in Facilitating Student Achievement on Different Instructional Tasks
by Thomas Jennings ---------- 280

Cognitive Style Predictors of Performance
by David H. Jonassen ---------- 293

The Effect of Level of Knowledge of the Subject on the Instructional Effectiveness of Illustrations Which Integrate Abstract and Realistic Visualization
by John Joseph ---------- 311

Coping with the Concrete Learner in the College Classroom
by Joanne Kurfiss ---------- 327

A Comprehensive and Critical Review of the Methodology and Findings in Color Investigations
by Richard Lamberski ---------- 337

Visual Instructional Strategies and Cognitive Style
by A. Arvo Leps ---------- 381

A Comparison of the Effectiveness of Massed and Distributed Practice Using Computer Assisted Adjunct Auto-Instruction as a Reviewing Method with College Students of Varying Abilities
by JoAnn Nelson ---------- 389

Assessment and the Control Function in Systems of Continuing Education
by Thomas Nielson ---------- 424

Research in Algorithmic Instruction: A Methodological Study
by Richard Schmid, Vernon Gerlach, and Miroslav Valach ---------- 440

Field-Dependence/Field-Independence and Instructional Development
by Dennis E. Sheriff and John A. Williams ---------- 445

Linking Task Analysis with Student Learning
by Thomas Sherman and Terry Wildman ---------- 460

Instructional Media, Attitude Formation and Change: A Critical Review of the Literature
by Michael R. Simonson ---------- 473

Relating What is to be Learned to What is Known: Subsumptive Sequencing, Co-ordination, and Cognitive Skills Activation
by Faith Stein, Jody Witham, and Charles Reigeluth ---------- 527

Narration, Detail and Event Relevance in Illustrated Materials
by Janet Whitaker and Howard Sullivan ---------- 569

Page

The Interactive Effects of Color and Cognitive Style on a Pictorial Recognition Memory Task
by Theodora Wieckowski --- 594

Matching Learning Theory, Instructional Technology, and Evaluation Design
by Terry Wildman and John Burton --------------------------------------- 630

Information Processing and Visual Communication: Implications of Theory for Research
by William Winn --- 646

TITLE: The Cognitive Effect in Bilingual Learners Given Different Pictorial Elaboration and Memory Tasks

AUTHORS: Carlos A. Acevedo

Richard J. Lamberski

THE COGNITIVE EFFECT IN BILINGUAL LEARNERS GIVEN DIFFERENT PICTORIAL ELABORATION AND MEMORY TASKS

Carlos A. Acevedo
Coordinator of the Learning Resource Center
Quincy Junior College

and

Richard J. Lamberski
Director - University Media Services
Assistant Professor - Division of Instructional Development
Boston University

Research & Theory Division
Association for Educational Communications & Technology
Denver, Colorado
Wednesday - April 23,1980

ABSTRACT

Purpose

The purpose of this investigation was to assess the relative achievement effect and processing time of bilingual students for different types of pictorial elaboration complementing audio-slide English instruction when given different memory tasks in either of their respective proficient languages (Spanish and English).

Rationale

A literature review indicated that the selection process for incorporating visual stimuli into the bilingual instructional environment lacks supportive empirical evidence. Generally, it is believed that the use of visualized materials, when used to complement oral or print instruction, is not equally effective in facilitating acquisition or retrieval of concepts. However, there is little evidence assessing the additive effect of different levels of pictorial elaboration on bilingual student achievement nor the related issue of which proficient language would be most effective and efficient in evaluating the acquired information.

Method

The sample consisted of 54 undergraduate bilingual students from a Puerto Rican university, who have a high degree of proficiency in the use of English but are native speakers of Spanish. Subjects were matched according to English proficiency scores and randomly assigned to one of six treatment conditions receiving externally paced audio-slide, English instruction complemented by one of three levels of pictorial elaboration (simple line drawings, simple line drawings with word labels, or word labels). Forty-eight hours later subjects received a self-paced, 80-item evaluation test measuring four different areas of cognitive knowledge (drawing, identification, terminology, and comprehension) in Spanish or English; subjects also recorded the amount of time spent interacting with each task test.

Results

Factor analysis and Schaffe post-hoc comparisons were performed on the achievement scores and processing time data, respectively, for a .05 level of significance. Achievement results indicate a significant pictorial elaboration test task interaction with later post-hoc comparisons, indicating that the simple line drawings with word labels were superior for the drawing task. Significant main effects for longer response time were found for subjects receiving instruction by simple line drawings with word labels and for subjects receiving Spanish evaluation. Plausible theories of bilingual information processing are discussed.

The Cognitive Effect in Bilingual Learners Given Different Pictorial Elaboration and Memory Tasks

Introduction

Although there is ample evidence substantiating that visual aids designed specifically to explain, clarify, and reinforce important concepts do facilitate learning (Carpenter & Greenhill, 1956; Lumsdaine & Sulzer,1951; VanderMeer, 1949), there is uncertainty as to the generalization of these findings,given current curriculum decisions and improved research design procedures (Torkelson, 1977). What has been evidenced suggests that pictorial illustrations can differentially affect learning (Dwyer, 1978), yet little is known about the effect of visualization on a bilingual population (Paulston, 1979). Indeed,the generalizability of the visual research on monlingual populations does not provide sufficient evidence for the following interrelated questions: (1) What type of pictorial materials should be used in teaching bilingual learners? (2) Are different types of pictorial elaboration equally effective? (3) What type of materials should be used for evaluating bilingual learners?

The research which has concentrated on the bilingual population has been limited to the linguistic or verbal aspects of memory (Lopez, 1972). Thus,the integration of these issues in a research investigation may produce relevant information that may help clarify the current controversies of single or dual processing and memory systems in bilingual students. This study,therefore,seeks to address these concerns,given the limited research base which integrates these multiple issues.

Purpose of the Study

The purpose of the investigation was to assess the relative effect on Spanish dominant bilingual students of different types of pictorial elaboration with audio-slide English instruction given different evaluative measures in their respective proficient languages. Specifically, the investigation measured the achievement scores and the amount of retrieval time of bilingual learners given:

1. externally presented English audio-slide instruction containing a type of pictorial elaboration (pictures only, pictures and words, or words only); and
2. self-paced evaluation measures in Spanish or English requiring different memory retrieval (drawing, identification, terminology, and comprehension).

Review of the Literature

An extensive review of the literature (see Acevedo, 1980) found that although the use of visualized materials has increased greatly over the years (Carpenter, 1953; Dwyer, 1972; Gropper, 1966), empirical evidence providing guidelines for the incorporation of visual materials into the instructional environment needs further investigation (Torkelson, 1977). The primary conclusion from this investigative area has been that the use of visualized materials to complement oral/print instruction produces different levels of achievement dependent upon various instructional characteristics and environments (Dwyer, 1978). This conclusion appears dependent upon the degree of realistic detail, method of presentation, student characteristics, type of evaluation, or other task features.

As used in the context of this study, pictorial elaboration (combinations of simple line pictures and word labels) attempts to facilitate learning of meaningful audio concepts by focusing the learner's attention on visual cues which would enhance their ability to extract the essential components of the presented information. Broadbent (1958, 1965) and Travers (1964, 1969) have suggested that too many irrelevant cues may actually compete for attention and subsequent information storage.

Further basis for the study was derived from investigations in human information processing and memory (Bower, 1972; Glanzer & Clark, 1963, 1964; Paivio, 1971). Research findings currently favor learners having a limited and selective information processing system and a dual (verbal and visual) memory system (Levie & Levie, 1975). Thus, structuring devices, such as codes for verbal and visual instruction,have been found to facilitate the encoding and decoding of concepts in what might otherwise be a complex task (Lamberski, 1980). However, evidence as to how these processes take place in the bilingual person has not been thoroughly investigated (McCormack, 1977). The emphasis on research dealing with memory and the bilingual student has been directed towards the linguistic components as opposed to the visualizing aspects (Kolers, 1963; Lopez, 1972, 1977; Rose, Rose, King, & Perez, 1975).

The authors hypothesized that the use of varying degrees of pictorial elaboration in relevant verbal and visual materials would produce differentiated achievement scores for Spanish dominant college learners.

Based on the literature, it was also hypothesized that the learners would perform better on the evaluative measures in the language of presentation (English).

Summary of the Methods

There were fifty-four Spanish dominant bilingual subjects who voluntarily participated in the investigation. All were enrolled in an undergraduate program of study at the Inter-American University of Puerto Rico. The students who participated demonstrated a moderate to high degree of proficiency in the use of the Spanish and the English languages (Acevedo, 1980, pp. 41-42).

An externally paced audio-slide instructional unit, adapted from Dwyer and Lamberski (1977/1980), was developed for the study. The concepts and processes conveyed in the twenty-one slide presentation,with accompanying 18 minute English audio-taped narration (see Acevedo, 1980, pp. 108-116), were on the human heart. A simple line drawing of the heart was used as the illustrative base for use with or without word labels; the word lables would also be used by themselves (see Appendix A). Thus, three versions of the presentation were prepared, identical in content except that one presentation had simple line pictures only for the illustrative component, the second had simple line pictures and word labels (see Acevedo, 1980, pp. 86-107), and the third had word labels only. Together, the three instructional presentations constituted one experimental factor - pictorial elaboration.

Two versions (English and Spanish) of an 80-item self-paced evaluative measure (see Acevedo, 1980, pp. 117-127), adapted from Dwyer and Lamberski (1977/1980), were also developed. Together, the two test versions constituted another experimental factor - language of evaluation. Both evaluative measures were identical in content, the difference being the language in which they were written. Each evaluative measure was divided into four task tests, each of which measured a different proportion of verbal or visual recall and application. The drawing test required the learner to draw a simple line drawing of the heart, labeling the drawing with twenty concept words which were provided. The identification test required the learner to recognize twenty numbered visual attributes of a provided simple line drawing of the heart. Each numbered visual attribute had a corresponding test item containing five multiple-choices. The terminology test required the learner for each of twenty items to complete a statement with a missing concept. For each of the twenty items, the learner was to select a concept word from a provided five-choice response list. The comprehension test consisted of twenty items which included a question or statement relating to a complex process of the heart. For each item the learner was required to select from a provided four-choice response list a concept word or function which related to the process. Distracter concepts (concepts not found in the instructional presentation)were added to some multiple-choice responses in the task tests. The four task tests constituted the third experimental factor - type of task test.

Experimental procedures for the investigation included three sessions. For the first experimental session, subjects reported to a central location where they were administered a 50-item English Proficiency Pretest.[1] At completion of the English Proficiency Pretest, subjects were matched by language proficiency and randomly assigned to one of six treatment groups (see Figure 1).

For the second experimental session, subjects reported to three separate treatment rooms, dependent upon their random-matched assignment. They were administered a 36-item, Physiology Pretest (see Dwyer, 1972, pp. 133-138) which measured prior biological knowledge of human anatomy and bodily functions. Later, they received one of three externally paced instructional presentations.

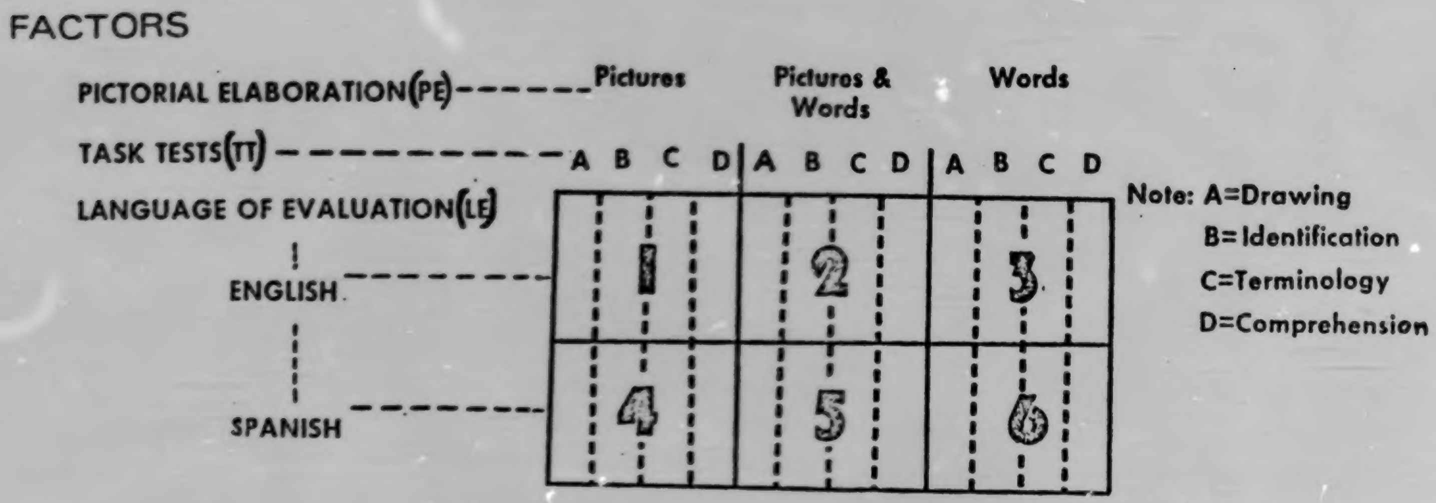
After forty-eight hours,subjects reported for the third experimental session to one of two assigned evaluation rooms (dependent upon their random-matched assignment),where they received the self-paced drawing test in Spanish or English. Upon completing and handing in the drawing test, the remaining self-paced evaluation tests (identification, terminology, and comprehension) were given to each subject. Starting time and completion time for all four tests were recorded by the subjects on a provided time card.

Research Design

The design chosen to test treatment conditions was an adaptation of the posttest-only, multiple treatment design,as described by Campbell and

---

[1] King, H.V., & Campbell, R.N. An English Reading Test for Students of English as a Foreigh Language. Portland, Oregon: English Language Services, 1975.


FACTORS
PICTORIAL ELABORATION(PE)
Pictures
Pictures & Words
Words
TASK TESTS(TT)
A B C D
A B C D
A B C D
LANGUAGE OF EVALUATION(LE)
ENGLISH
SPANISH
1
2
3
4
5
6

Note: A=Drawing
B= Identification
C=Terminology
D=Comprehension

Note: Subjects were ranked from high to low by proficiency scores from an English ability test where upon the subjects were randomly assigned to one of six treatment conditions 1,2,3,4,5,6 as matched on their proficiency scores.

FIGURE 1 OVERALL RESEARCH DESIGN.

Stanley (1966). This design insures control over many irrelevant variables which may cause systematic bias and minimizes threats to internal and external validity (Myers, 1966).

The investigation manipulated three independent variables in examining the dependent achievement data (number of correct responses for each of the four task tests). Independent variables in this analysis were type of pictorial elaboration (pictures only, pictures and word labels, and word labels only); language of evaluation (English or Spanish); and type of evaluative measure (drawing test, identification test, terminology test, and conprehension test).

The investigation also manipulated two independent variables in examining the dependent task time data (amount of time required to interact with all of the four tests). Independent variables in this analysis were type of pictorial elaboration received (pictures only, pictures and word labels, and word labels only) and language of evaluation (English or Spanish).

Minimum significance level was .05 for all a priori and post-hoc mean comparisons.

Two separate 2 x 3 factorial analyses were performed on the English Proficiency Pretest and the Physiology Pretest data to determine if subject mortality which occurred after matched randomization to treatment conditions resulted in cell bias. Results (see Acevedo, 1980, pp. 41-45) indicated subjects (n = 54) remaining within unequal cell conditions contained no significant differences on these two indices.

Hypotheses and Results

The hypotheses for the learner achievement data (number of correct item responses for each of the task tests) were analyzed using a 2 x 3 x (4) mixed factorial analysis of variance for repeated measures with subsequent post-hoc mean comparisons. The factorial analysis represented in Table 1 and illustrated in Figure 2 is based upon the means and standard deviations for the treatment groups found in Appendix B. Diagnostic data and Hoyt's Estimate of Reliability for the individual tast tests has been provided in Appendix D.

The hypotheses and results are as follows.

Hypothesis 1. Spanish dominant bilingual learners who receive an English audio-slide presentation containing pictorial elaboration of simple line pictures with word labels will obtain significantly greater achievement means on the four criterion measures given in English or Spanish than Spanish dominant bilingual learners who receive the identical presentation containing pictorial elaboration of pictures only or of words only.

The two-way interaction between task test and pictorial elaboration was less than a .01 level of significance. This implies that while pictorial elaboration does not significantly affect each mean difference for respective treatment conditions, it may affect one or more of the task test comparisons. Post-hoc mean comparisons further substantiated this finding (see Table 2) for the drawing test. Mean achievement scores for the respective treatment groups on the four tasks indicated that the criterion measures assessed different levels of content recall and application and may reflect varying degrees of task difficulty.

TABLE 1

ANALYSIS OF VARIANCE OF CRITERION MEASURE SCORES FOR TREATMENT GROUPS

Source of Variation	df	Mean Square	F	Probability
Language of Evaluation (LE)	1	21.93	0.42	0.52
Pictorial Elaboration (PE)	2	50.23	0.97	0.39
LE x PE	2	59.84	1.16	0.32
Residual	48	51.74		
Task Test (TT)	3	96.27	16.32*	0.01
TT x LE	3	11.19	1.90	0.13
TT x PE	6	15.46	2.62*	0.01
TT x LE x PE	6	3.38	0.57	0.75
Residual	144	5.90		

*p <.05

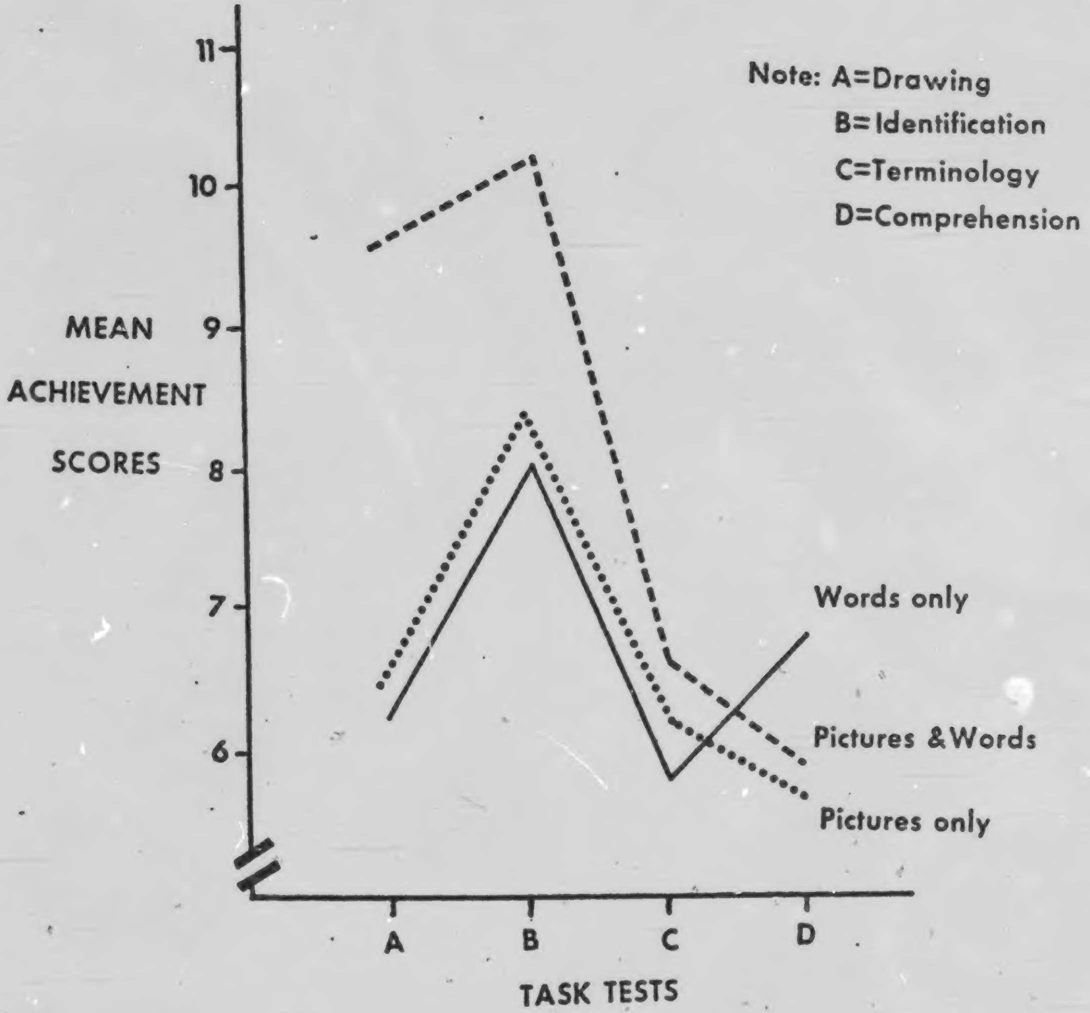


FIGURE 2 PLOT OF MEAN SCORES VERSUS CRITERION MEASURES FOR TYPES OF PICTORIAL ELABORATION

TABLE 2

SCHEFFÉ'S MEAN SCORE COMPARISONS FOR PICTORIAL ELABORATION ON CRITERION MEASURES

PE Mean Comparisons	Drawing	Identification	Terminology	Comprehension
$PE_{(1+4)}$ vs $PE_{(2+5)}$	F=7.53*	F=2.51	F=0.05	F=0.05
$PE_{(1+4)}$ vs $PE_{(3+6)}$	F=0.18	F=0.02	F=0.02	F=0.85
$PE_{(2+5)}$ vs $PE_{(3+6)}$	F=8.86*	F=3.14	F=0.54	F=0.55

*p <.05

Where : df = 2.50; critical F .05 value = 3.18

$PE_{(1+4)}$ = TR 1 (picture only, English evaluation) plus
TR 4 (picture only, Spanish evaluation)

$PE_{(2+5)}$ = TR 2 (picture and words, English evaluation) plus
TR 5 (picture and words, Spanish evaluation)

$PE_{(3+6)}$ = TR 3 (words only, English evaluation) plus
TR 4 (words only, Spanish evaluation)

Hypothesis 2. Spanish dominant bilingual learners who receive an English audio-slide presentation containing different levels of pictorial elaboration with an English evaluative test will obtain significantly greater achievement means on the four criterion measures than Spanish dominant bilingual learners who receive the identical presentation but given a Spanish evaluative test.

Main effects due to language of evaluation or subsequent factor interaction were found not to be significant. This implied that the language of evaluation did not significantly affect performance on any of the individual task tests. Thus, Hypothesis 2 was not supported.

Hypothesis 3. Spanish dominant bilingual learners who receive an English audio-slide presentation containing different levels of pictorial elaboration will obtain significantly greater means on the test measures that require more visual retrieval than those test measures that require verbal retrieval.

The addition of pictorial elaboration to the English audio narration during instruction did not produce the significantly greater mean achievement scores for the more visual than verbal retrieval tasks for each pictorial elaboration condition. Rather, as the main and post-hoc analyses indicate, significance is dependent upon type of pictorial elaboration (picture and word labels) and type of task (drawing test). It should be noted, however in the identification task test, a trend existed that also suggested that pictures and word labels were more effective than word labels alone or pictures alone in this more visual retrieval task.

The hypothesis for the learner time data (amount of total time spent interacting with all four task tests) was analyzed using a 2 x 3 factorial analysis of variance with subsequent post-hoc mean comparisons.

TABLE 3

ANALYSIS OF VARIANCE ON TIME CRITERION MEASURE FOR TREATMENT GROUPS

Source of Variation	df	Mean Square	F	Probability
Language of Evaluation (LE)	1	2063.20	11.85*	0.001
Pictorial Elaboration (PE)	2	848.21	4.87*	0.012
LE x PE	3	21.51	0.12	0.88
Residual	48	174.10		

*p < .05

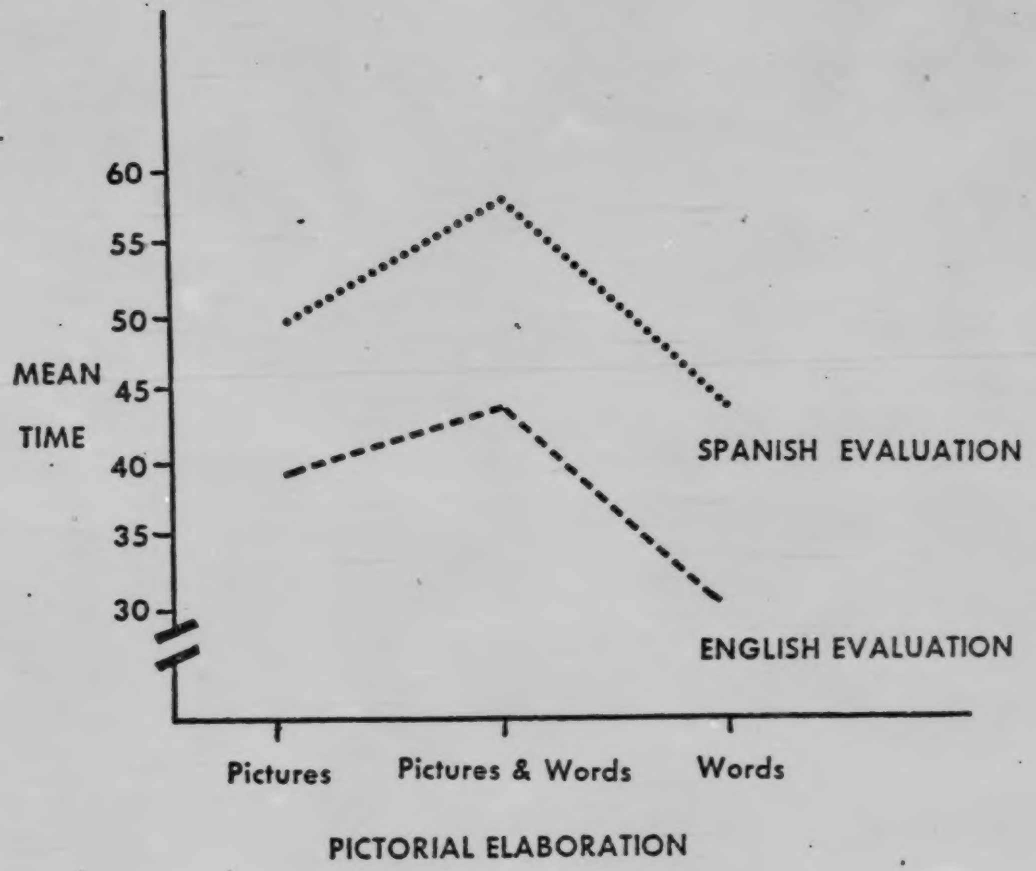


FIGURE 3 PLOT OF MEAN TIME VERSUS TYPE OF LANGUAGE OF EVALUATION FOR TYPE OF PICTORIAL ELABORATION

TABLE 4

SCHEFFÉ'S MEAN TIME COMPARISONS FOR PICTORIAL ELABORATION

PE Mean Comparisons	Scheffé's F
$PE_{(1+4)}$ vs $PE_{(2+5)}$	0.36
$PE_{(1+4)}$ vs $PE_{(3+6)}$	1.19
$PE_{(2+5)}$ vs $PE_{(3+6)}$	3.14

*$p < .05$

Where: df = 2.50; critical F value = 3.18

$PE_{(1+4)}$ = TR 1 (picture only, English evaluation) plus TR 4 (picture only, Spanish evaluation)

$PE_{(2+5)}$ = TR 2 (pictures and words, English evaluation) plus TR 5 (pictures and words, Spanish evaluation)

$PE_{(3+6)}$ = TR 3 (pictures only, English evaluation) plus TR 6 (pictures only, Spanish evaluation)

The factorial analysis represented in Table 3 and illustrated in Figure 3 is based upon the means and standard deviations for the treatment groups found in Appendix C.

Hypothesis 4. Spanish dominant bilingual learners who receive an English audio-slide presentation with different levels of pictorial elaboration with an English evaluative test will require a significantly smaller mean time to retrieve the information than Spanish dominant bilingual learners who receive an identical presentation but with a Spanish evaluative test.

Both the language of evaluation and pictorial elaboration had a significant effect on the total time required to complete the tests.

The main effect of language of evaluation indicates that those students who were given the evaluation in English performed significantly faster than those given the evaluation in Spanish. Post-hoc comparisons (Table 4) on the main pictorial elaboration effect, while not significant, suggested that those students given the word labels only presentation performed faster than those given the pictures only presentation or the pictures with word label presentation. While post-hoc comparisons failed to reach the specified level of significance, this could be partially explained in that the power of the post-hoc comparisons does not equal or exceed the power of the overall test of means.

Interpretation of the Findings

Discussion of Hypothesis 1

The finding that externally paced audio-slide English presentations with simple line drawings and word labels were more effective for the drawing task measure for bilingual learners (together with the same trend in the identification task measure) appears to be supportive of the contention that two referents during the acquisition of the desired concept facilitate the later retrieval of information in tasks requiring more visual information (Gropper, 1966). Other retrieval tasks requiring more verbal solution did not produce significant mean differences for different pictorial elaboration conditions, as has been generally found for monolingual subjects (Dwyer, 1972).

This finding also partially supports the cue summation theories (Black, 1962; Rappaport, 1957; Rosonke, 1974; Travers, 1969) which suggested that the addition of cues to instructional materials will provide increased achievement. However, this finding did not necessarily support the contention that learning does conform to a linear relationship which is dependent upon the number or complexity of the cues employed (Fitts, 1956; Vitz, 1966). Rather, the data suggested that the value of cues for instruction was highly dependent upon the retrieval task (Dwyer, 1972).

The finding that word labels only and pictures only were less effective than pictures and word labels was consistent with cognitive theories which maintain that if a learner does not previously have a set of codes (natural language mediators) to identify with, learning will not be enhanced (Paivio, 1971). By providing word labels in addition to the simple line drawings, the materials provided mediation enhancing the encoding or decoding strategies. Paivio (1971) contends that these two systems of processing information, images and verbal, would significantly enhance learning; the data appears to support this contention for bilingual learners.

Since codes were provided in the picture and word label conditions, learners may have been better able to encode the more information-rich audio narration. Thus, it is possible that the visual presentation was a reinforcing element to the visualizing, locating, and associating of elements, initiating the construction of mental images and verbal associations.

The dual encoding of information,however,does not seem to produce any significant differences as the retrieval task becomes more sequential or verbal. In these criterion measures having two referents appears redundant to the task retrieval requirement.

Discussion of Hypothesis 2

The finding that retrieval recall or application was not significantly affected with the alteration of languages from instruction to testing was inconsistent with the stimulus generalization theories which suggested a significant effect for identical learning and testing materials (Hartman, 1961; Severin, 1967). If the results had been consistent with these theories, the bilingual student would have obtained better scores for an evaluation that was carried out in the same language of instruction (Fryetes, 1977). Pictures with word labels in English seemed to have facilitated the acquisition of English narrative information,but once the concept was acquired, the retrieval advantage of a specific language in testing became irrelevant. It should be noted that a Spanish presentation may alter this interpretation.

Discussion of Hypothesis 3

Results and interpretation again reflect the interaction of pictorial elaboration with type of task test and subsequent post-hoc comparisons. As previously noted, achievement on the more visual tasks (drawing test and the trend noted for the identification test) was enhanced by the dual representation during presentation. Also,the opposite is possible-that pictures with word labels during presentation could have been distracters that affected achievement on the more verbal tasks during recall and application. This would tend to support the contention that higher order cognitive memory is more dependent upon the availability of a verbal code and not necessarily a visual one (Del Castillo & Gumenik, 1972).

Given this contention,it is possible that word labels only or pictures only might have made easier the coding of the verbal narrative information during presentation serving as natural language mediators in later verbal retrieval tasks which require more abstract and sequential information for solution rather than the more concrete and spatial.

Discussion of Hypothesis 4

The finding that language of evaluation does significantly affect the time required to complete the testing instrument is supportive of the theory of two independent linguistic systems and the dual system hypothesis for bilingual learners (Kolers, 1963; Paivio, 1971). The delay in completing the Spanish test was probably due to code-switching. Thus, the concept of a single storage area from which each language draws its responses was not supported since there was no immediate transfer (Kolers, 1963; Tulving &

Colotla, 1970). The information appears to have been acquired in the language of presentation and more readily retrievable when the same language was available at task testing. Where the Spanish test required another processing step to derive the correct solution, MacNamara (1967) has indicated that this transfer may reflect a stage of relearning a second language. However, since the students had been exposed to English as a second language for at least twelve years, this seems less likely.

The results should emphasize that this code-switching process did not affect learner achievement; the cognitive requirement merely took longer to process and derive the correct solution. An alternative to investigate is that if students were provided practive or feedback during instruction, the results may be different.

The finding that bilingual students who received the presentation with word labels only performed faster on the evaluative test than the other groups may indicate that they had less coded information to access, particularly since their achievement scores were less.

Conclusions

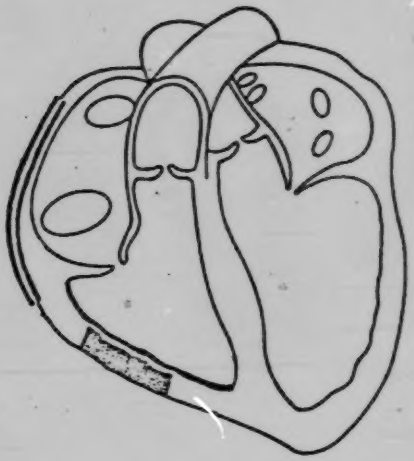
If designers of externally paced visualized instruction and self-paced evaluation are to be responsive to the results of the empirical evidence, it would be important to give specific attention to the structure of different types of presentations in providing instructional content to bilingual learners. The selection of a specific method of pictorial elaboration appears dependent upon the learning and retrieval task involved.

Specifically,as the self-paced retrieval task in testing requires more visual than verbal recall or application, simple line pictures with word labels during English instruction appear to enhance the Spanish dominant learner's achievement more than the pictures alone or word labels alone. Language of evaluation does not appear to be a relevant variable in relation to overall achievement, but does influence the amount of time necessary for completion of criterion measures. Specifically, self-paced English evaluation appears most efficient for Spanish dominant bilingual learners when instructed by externally paced English presentations.

Thus, this study indicates that when interaction is allowed with different types of pictorial elaboration during presentation of concepts, bilinguals will achieve different performance levels for different cognitive memory tasks.

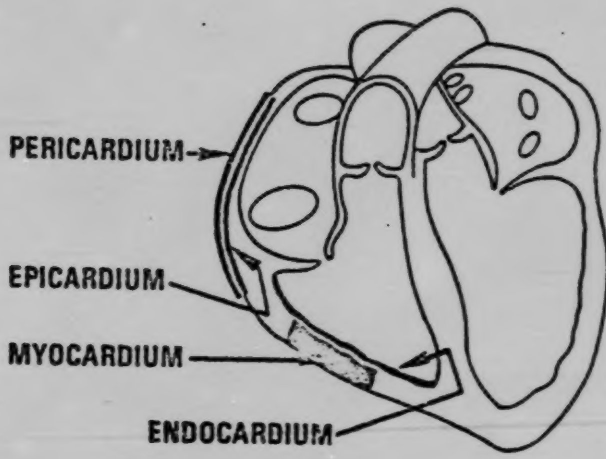
APPENDIX A

EXAMPLE OF PICTURES ONLY



EXAMPLE OF PICTURES

& WORDS


PERICARDIUM
EPICARDIUM
MYOCARDIUM
ENDOCARDIUM

EXAMPLE OF WORDS ONLY

PERICARDIUM

EPICARDIUM

MYOCARDIUM

ENDOCARDIUM

APPENDIX B

MEANS AND STANDARD DEVIATIONS OF CRITERION MEASURE SCORES FOR TREATMENT GROUPS

Treatment Groups (TR)	n	Indices	Task Tests			
			A	B	C	D
1	6	$\overline{X}$	6.00	9.33	4.67	5.67
		SD	6.42	4.41	3.01	2.88
4	10	$\overline{X}$	6.70	7.80	7.10	5.70
		SD	5.12	5.16	3.84	3.40
PE (Pictures)	16	$\overline{X}$	6.44	8.38	6.19	5.69
		SD	5.44	4.80	3.66	3.11
2	12	$\overline{X}$	10.25	10.75	6.58	6.42
		SD	4.43	3.82	3.53	3.45
5	8	$\overline{X}$	8.63	9.38	6.63	5.25
		SD	5.24	5.66	4.17	2.76
PE (Pictures + Words)	20	$\overline{X}$	9.60	10.22	6.60	5.95
		SD	4.71	4.55	3.69	3.17
3	7	$\overline{X}$	4.00	7.43	4.14	5.14
		SD	4.16	2.99	2.48	2.79
6	11	$\overline{X}$	7.73	8.73	6.82	7.82
		SD	4.36	4.82	4.07	4.07
PE (words)	18	$\overline{X}$	6.28	8.22	5.78	6.78
		SD	4.56	4.15	3.70	3.78

Note: where - TR1 = Picture only, English Evaluation
TR2 = Picture + Words, English Evaluation
TR3 = Words only, English Evaluation
TR4 = Picture only, Spanish Evaluation
TR5 = Picture + Words, Spanish Evaluation
TR6 = Words only, Spanish Evaluation

A = Drawing Task Test
B = Identification Task Test
C = Terminology Task Test
D = Comprehension Task Test

PE = Levels of Pictorial Elaboration

APPENDIX C

MEANS AND STANDARD DEVIATION OF TIME FOR TREATMENT GROUPS

Language Evaluation (LE)	Indices	Pictorial Elaboration (PE)			Total (LE)
		Picture	Picture + Words	Words	
English					
	$\bar{X}$	39.17	43.42	30.43	38.76
	SD	13.03	11.93	3.55	11.61
	n	(6)	(12)	(7)	(25)
Spanish					
	$\bar{X}$	49.40	58.13	43.73	49.66
	SD	14.51	22.02	7.60	15.62
	n	(10)	(8)	(11)	(29)
(PE) Total					Grand Total
	$\bar{X}$	45.56	49.30	38.56	44.61
	SD	14.46	17.77	9.11	4.83
	n	(16)	(20)	(18)	(54)

APPENDIX D

RELIABILITY FIGURES FOR THE INDIVIDUAL TASK TESTS

Indices	Task Tests			
	Drawing	Identification	Terminology	Comprehension
Mean	7.56	9.00	6.20	6.15
Standard Deviation	5.05	4.51	3.63	3.34
High Score*	17	18	18	16
Low Score*	0	2	1	2
Hoyt's	0.86	0.80	0.69	0.58
Standard Error	1.81	1.87	1.90	1.95

*Total number of possible scores in each task test is 20 points.

Note: Total number of individuals taking tests was 54 subjects.

REFERENCES

Acevedo, C. Effects of pictorial elaboration on Spanish dominant bilingual students for memory tasks in respective languages of proficiency. Unpublished doctoral dissertation, Boston University, 1980.

Black, H.B. Improving the programming of complex pictorial materials: Discrimination learning as affected by prior exposure to a relevance of components of the figural discrimination (NDEA Title VII Report Project No. 688). Washington, D.C.: U.S. Office of Education, 1962.

Bower, G.H. Perceptual groups as coding units in immediate memory. Psychonomic Science, 1972, 27(4), 217-219.

Broadbent, D.E. Perception and communication. New York: Pergamon Press, 1958.

Broadbent, D.E. Information processing in the nervous system. Science, 1965, 457-462.

Campbell, D.T., & Stanley, J.C. Experimental and quasi-experimental designs for research. Chicago: Rand McNally, 1966.

Carpenter, C.R. A theoretical orientation for instructional research. AV Communication Review, 1953, 1, 38-52.

Carpenter, C.R., & Greenhill, L.P. Instructional film research reports (Vol. II Technical Report, SDC-269-7-61). Port Washington, N.Y.: Special Devices Center, Office of Naval Research, 1956.

Del Castillo, D.M., & Gumenik, W.E. Sequential memory for familiar and unfamiliar forms. Journal of Experimental Psychology, 1972, 9(1), 90-96.

Dwyer, F.M., Jr. A guide for improving visualized instruction. State College, PA: Learning Services, 1972.

Dwyer, F.M., Jr. Strategies for improving visual learning. State College, PA: Learning Services, 1978.

Dwyer, F.M., Jr., & Lamberski, R.J. The human heart (instructional booklets and test materials). Supplement to R.J. Lamberski, The effect of a verbal and visual color code on self-paced instruction and testing for retention on different tasks. Unpublished doctoral dissertation, The Pennsylvania State University, 1980. (Originally published, 1977.)

Fitts, P.M., Rappaport, M., Weinstein, M., Anderson, N., & Leonard, J.A. Stimulus correlates of visual pattern recognition: A probability approach. Journal of Experimental Psychology, 1956, 5, 1-11.

Freytes-Dieppa, C. Paired-associate learning with Spanish and English mediation in a bilingual population (Doctoral dissertation, Boston University, 1977). Dissertation Abstracts International, 1977, 38, 2040A. (University Microfilms No. 77-21, 641)

Glanzer, M., & Clark, W.H. The verbal loop hypothesis: Binary numbers. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 301-309.

Glanzer, M., & Clark, W.H. The verbal loop hypothesis: Conventional figures. American Journal of Psychology, 1964, 77, 621-626.

Gropper, G.L. Learning from visuals - Some behavioral considerations. AV Communication Review, 1966, 14, 37-69.

Hartman, F.R. Recognition learning under multiple channel presentation and testing conditions. AV Communication Review, 1961, 9, 24-43.

Kolers, P.A. Interlingual word associations. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 291-300.

Lamberski, R.J. The effect of a verbal and visual color code on self-paced instruction and testing for retention on different tasks. Unpublished doctoral dissertation, The Pennsylvania State University, 1980.

Levie, W.H., & Levie, D. Pictorial memory processes. AV Communication Review, 1975, 23(1), 81-97.

López, M. Bilingual memory research: Implications for bilingual education. In G.L. Martinez (Ed.), Chicano Psychology. New York: Academic Press, 1972.

López, M. Linguistic interference and the academic achievement of Mexican-American. Paper presented at the meeting of the Rocky Mountain Psychological Association, Salt Lake City, May, 1975.

Lumsdaine, A.A., & Sulzer, R.L. The influence of simple animation techniques on the value of a training film (U.S. Air Force Human Factors Research Lab. Report No. 24). Washington, D.C., 1951.

MacNamara, J. The bilingual's linguistic performance - A psychological overview. Journal of Social Issues, 1967, 23, 58-77.

McCormack, P.D. Bilingual linguistic memory: The independence-interdependence issue revisited. In P.A. Hornby (Ed.), Bilingualism: Psychological, social, and educational implications. New York: Academic Press, 1977.

Myers, J.L. Fundamentals of experimental design. Boston: Allyn & Bacon, 1966.

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart, & Winston, 1971.

Paulston, C.B. Bilingual/bicultural education. In L.S. Shulman (Ed.), Review of Research in Education (Vol. 6). Itasca, Illinois: F.E. Peacock Publishers, Inc., 1979, 186-228.

Rappaport, M. The role of redundancy in discrimination of visual forms. Journal of Experimental Psychology, 1957, 53, 3-10.

Rose, R.H., Rose, P.R., King, N., & Perez, A. Bilingual memory for related and unrelated sentences. Journal of Experimental Psychology: Human Learning and Memory, 1975, 1, 599-606.

Rosonke, R.J. A study of the effectiveness of three visual attention directing devices on the recall of relevant information from line drawings (Doctoral dissertation, University of Iowa, 1974). Dissertation Abstracts International, 1975, 35(07), 4316A. (University Microfilms No. 75-01250)

Severin, W.J. Cue summation in multiple channel communication (Doctoral dissertation, University of Wisconsin, 1967). Dissertation Abstracts International, 1967, 28(07), 2640A. (University Microfilms No. 67-10649)

Torkelson, G.M. AVCR - One quarter century: Evolution of theory research. AV Communication Review, 1977, 25(4), 317-358.

Travers, R.M.W. The transmission of information to human receivers. AV Communication Review, 1964, 12, 373-385.

Travers, R.M.W. A study of the advantages and disadvantages of using simplified visual presentations in instructional materials (Final Report, Grant No. OEG-1-7-070144-5235). Washington: U.S. Department of Health, Education, and Welfare, Office of Education, 1969 .

Tulving, E., & Colotla, V.A. Free recall of bilingual lists. Cognitive Psychology, 1970, 1, 86-98.

VanderMeer, A.W. Relative effectiveness of instruction by film exclusively, films plus study guides and standard lecture methods (Technical Report, SDC-269-7-13, Special Devices Center). Port Washington, New York: Office of Naval Research, 1949.

Vitz, P.C. Preference for different amounts of visual complexity. Behavioral Science, 1966, 11, 105-114.

TITLE: The Relationship of Communication Apprehension Level and Media Competency

AUTHOR: Cheryl A. Anderson

THE RELATIONSHIP OF COMMUNICATION APPREHENSION LEVEL AND MEDIA COMPETENCY

A Paper

By

Dr. Cheryl A. Anderson
University of Texas at Austin

THE RELATIONSHIP OF COMMUNICATION APPREHENSION LEVEL AND MEDIA COMPETENCY

Dr. Cheryl Anderson
University of Texas at Austin

Introduction

The identification of variables which determine users and nonusers of media in the classroom is important to media educators because decisions must be made as to the best methods for persuading nonusers to make media an integral part of their instruction. There have been numerous studies which have attempted to isolate utilization variables, however, the findings are frequently contradictory. The variables studied have included: grade level, subject taught, media training, media competency, barriers to utilization, attitudes toward media, sex, teaching experience, mechanical ability, and personality traits.

Recently, Dunathan and Powers (1979) linked the personality trait of communication apprehension (CA) to past and projected future use of media among preservice teachers. Communication apprehension is generally defined as a fear of oral communication. This trait can have a negative impact upon a person's life. Research indicates that a person with high CA is viewed less positively by teachers, employers, and peers (McCroskey, 1977). A person with high CA will seek to avoid any type of communication activity. Dunathan and Powers conclude that this avoidance can be expanded to include technologically based communication as well.

In their study, Dunathan and Powers asked beginning education majors enrolled in a required introduction to education course to indicate on a 10-point scale (see appendix) their past and projected future use of ten instructional media: motion pictures, television, overhead, audio, slides, filmstrips, models, games and charts. Students were also given McCroskey's Personal Report on Communication Apprehension (PRCA, 1970,see appendix). The researchers concluded that high and moderate CA individuals tend to group together in their past and projected future media use. These two groups, which made up 85% of the sample, reported significantly less media use than the low CA group. This finding was repeated in another Powers and Dunathan study (1979) that was conducted with ending education majors. Thus, communication apprehension appears to be a possible factor in media utilization.

As of yet no specific media competencies have been empirically related to media use. However, most experts would agree that general competency in media requires knowledge in selection, utilization, production, equipment operation, and evaluation of media (Fulton, 1960; Meierhenry,1966; Pascoe, 1957;White, 1953). In addition, teachers, administrators, and media educators feel that knowledge of production skills and training in other aspects of media are important in teacher education (Brookens, 1970; Busse, 1976; Ford, 1974; Haselwood, 1972; Kennard, 1973; King, 1967; Meierhenry, 1967; Mars and Bergeson, 1970; Romano and Speiker, 1974; and Salley, 1965)

Streeter (1969) is the only study which has successfully related media competency to media utilization. Using Meierhenry's competencies (1966), Streeter questioned teachers and found a positive correlation of .41 between media competency and frequency of use. Twelve of the competencies were identified as potential influencing factors in media utilization. Only five of these were possessed by the teachers and yet two-thirds of them had received media training. This may indicate that training in media is not neccessarily related to media competency.

Purpose of the Study

From the literature, it is possible to suggest that media competency can be correlated with media utilization. It is also possible to suggest that CA is an indication of media utilization. What then is the relationship between CA level and media utilization? The purpose of this study was to investigate the relationship between CA level and the attainment of media competencies which are fundamental to the production of basic media, and the relationship between the attainment of competency and the future use of media among preservice teachers. The first null hypothesis was that there would be no significant differences in the achievement of media competencies among the three levels of CA subjects. The second null hypothesis was that there would be no significant correlation between the attainment of media competency and the projected future use of ten common classroom media.

Methods and Procedures

A quasi-experimental design was used because the subjects were an intact group who were enrolled in the Winter 1979 semester of a basic media course at the University of Missouri-Columbia. The experiment was conducted over an eight week period and involved only production skills. At the beginning of the course ninty-two subjects were tested for CA level using the PRCA and asked to indicate their plans for the use of media on Dunathan's and Powers' Media Utilization Scale.

The PRCA is a self-report instrument which delineates individuals who are high, moderate, and low CA. High CA indicates an individual who is fearful of communicative encounters. According to McCroskey's(1977) standard procedures, a score which falls one standard deviation above the mean indicates a high CA person. A moderate CA individual is one who exhibits some disomfort in communicative encounters. A PRCA score which falls ± one standard deviation from the mean indicates a moderate CA. Low CA is represented by a person who is quite comfortable in communicative encouters. A score which falls more than one standard deviation below the mean indicates a low CA individual. The data collected are reported in Table 1.

TABLE 1

PRCA RESULTS

Level of CA	Number of Students	Range of Scores
Low CA	13	33 - 56.21
Moderate CA	64	56.22 - 83.78
High CA	15	83.79 - 113

N = 92 Mean = 70 Standard deviation = 13.78

In testing the first null hypothesis eight tasks were designed to develop production skills in picture mounting, lettering, illustration, and design. These were evaluated by three qualified judges using the researcher's Media Production Skill Scale (MPSS, see appendix) which rates each task according to specific criteria on a

5-point scale. The data was analyzed using a Krusal-Wallis one way analysis of variance. In testing the second null hypothesis the composite scores from the MPSS and the averages from the Media Utilization Scale were correlated using the Spearman rank coefficient. The level of significance was set at .05.

Findings

In testing the first hypothesis the .05 level of significance had an H value of 5.99 with two degrees of freedom. The null hypothesis was rejected in three of the tasks. CA level was significantly related to the competencies of squared reduction, projected enlargement, and hand lettering. The H value for squared reduction (18.74) was significant at the .005 level. The H value for projected enlargement (10.76) was significant at the .01 level. The H value for hand lettering(6.86) was significant at the .05 level. Commercial lettering (H=-4.82) approached the .05 level of significance indicating a possible relationship between CA and this Particular media competency. CA level was not significantly related to the competencies of dry mounting, rubber cement mounting, mechanical lettering, and design. In all but two tasks (mechanical lettering and dry mounting) the low CA group produced the lowest mean rank. The data are reported in Table 2.

The second null hypothesis was accepted. The reults of the Spearman rank coefficient are reported in Table 3. A correlation coefficient of -.0725 was obtained. The t value of .61 was not significant at the .05 level (t=2.00) with 71 degrees of freedom.

TABLE 2

RELATIONSHIP OF CA LEVEL TO MEDIA COMPETENCY

Assignment	Rank Means			
	Low	Moderate	High	H value
Squared Reduction	38.00	44.20	50.82	18.74***
Projected Enlargement	27.92	45.86	42.96	10.86**
Dry Mounting	43.00	46.68	38.11	-0.60
Rubber Cement Mounting	34.79	48.32	36.78	-1.22
Commercial Lettering	35.86	42.06	45.75	-4.82
Mechanical Lettering	39.96	44.15	33.46	-1.06
Hand Lettering	35.45	41.29	41.33	6.86*
Design and Composition	35.55	42.62	38.46	0.026

*significant at the .05 level
**significant at the .01 level
***significant at the .005 level

TABLE 3

RELATIONSHIP OF PROJECTED MEDIA UTILIZATION TO MEDIA COMPETENCY

$r_s = -.0725$ $N = 73$

$t = .61$ $df = 71$

Not significant at the .05 level

Discussion

In analyzing the data two patterns emerged: (1) the low CA groups received the lowest scores on a majority of the tasks; and (2) the type of task which produced significant results required good eye-hand coordination. The high and moderate CA groups excelled in the tasks of squared reduction, projected enlargement, and hand lettering,however, when the task required the use of mechanical or commercial devices, there was no significant differences among the groups.

A possible explanation for these findings may be found in the literature on CA. McCroskey (1977) has found low CA individuals to be less anxious and more easy going. This may have affected their approach in attempting these visual tasks. The approach may have been one of "winging it", resulting in lower scores. The high CA individual is more anxious, more task oriented and therefore, may have taken the visual tasks more seriously, resulting in higher scores.

The low scoring on the part of the low CA group is not typical of their academic performance. Research has documented that the low CA individual maintains a higher grade point average than the high CA individual (McCroskey and Anderson, 1976). Another possible explanation is that, because the high CA person is less capable and less comfortable in dealing with oral communication, the high CA individual may actually excell in visual skills. The reverse being the case for the low CA individual. This study's findings indicate that the low CA group may have some visual handicap which can be overcome when mechanical devices are used. These findings also indicate that the high and moderate CA individuals have some natural visual ability.

The findings of no significant correlation between media competency and media utilization in testing the second hypothesis is consistent with the findings of the first hypothesis. If competency in production skill was related to media utilization, it would have been logical to expect the low CA group to obtain higher scores and greater media competency, however, the reverse proved to be true.

Questions still remain: if the high and moderate CA groups have the competency to produce media, why do they choose not to use it and why is the reverse true for the low CA group? The answer may lie in the way media is perceived. If media is viewed as being an extension of verbal communication rather than visual communication, it is logical that the low CA individual would use media and the high CA individual would not. The findings of this study may have some implications for the media educator. If CA is related to media utilization and media competency is not, then the treatment of communication apprehension becomes an important tool in encouraging teachers to use media. Media production training is also important, but if it cannot guarantee media utilization then it is time to look for other methods which will.

Summary

Again, the purpose of this study was to investigate the relationship of communication apprehension level and media competency, and the relationship between attainment of media competency and future media utilization. The first null hypothesis that there would not be a significant difference in the achievement of media competencies fundamental to the production of media among the three levels of communication apprehension was rejected in three of the eight competencies. These were squared reduction, projected enlargement, and hand lettering. The second null hypothesis that the attainment of these media competencies would not correlate with projected future use of ten common classroom media was accepted.

APPENDIX

PERSONAL REPORT ON COMMUNICATION APPREHENSION

DIRECTIONS: This instrument is composed of 25 statements concerning your communication with other people. Please indicate the degree to which each statement applies to you by marking whether you:
1) Strongly Agree, 2) Agree, 3) Are Undecided, 4) Disagree, or
5) Strongly Disagree with each statement. There are no right or wrong answers. Work quickly, just record your first impression.

1. While participating in a conversation with a new acquaintance I feel very nervous.
2. I have no fear of facing an audience.
3. I talk less because I'm shy.
4. I look forward to expressing my opinions at meetings.
5. I am afraid to express myself in a group.
6. I look forward to an opportunity to speak in public.
7. I find the prospect of speaking mildly pleasant.
8. When communicating, my posture feels strained and unnatural.
9. I am tense and nervous while participating in group discussions.
10. Although I talk fluently with friends, I am at a loss for words on the platform.
11. I have no fear about expressing myself in a group.
12. My hands tremble when I handle objects on the platform.
13. I always avoid speaking in public if possible.
14. I feel that I am more fluent when talking to people than most other people are.
15. I am fearful and tense all the while I am speaking before a group of people.
16. My thoughts become confused and jumbled when I speak before an audience.
17. I like to get involved in group discussions.
18. Although I am nervous just before getting up, I soon forget my fears and enjoy the experience.
19. Conversing with people who hold positions of authority causes me to be fearful and tense.
20. I dislike to use my body and voice expressively.
21. I feel relaxed and comfortable while speaking.
22. I feel self-conscious when I am called upon to answer a question or give an opinion in class.
23. I face the prospect of making a speech with complete confidence.
24. I'm afraid to speak up in conversations.
25. I would enjoy presenting a speech on a local television show.

To compute the PRCA score, follow these three steps:

1. Add the scores for items 1, 3, 5, 8, 9, 10, 12, 13, 15, 16, 19, 20, 22, and 24.
2. Add the scores for items 2, 4, 6, 7, 11, 14, 17, 18, 21, 23, and 25.
3. Complete the following formula:
   PRCA = 84 - (total from step 1) + (total from step 2)

MEDIA UTILIZATION SCALE

ON THE FOLLOWING ITEMS PLEASE BLACKEN THE CORRESPONDING NUMBER REPRESENTING YOUR REACTION TO EACH ITEM.

To what extent do you plan to use the following instructional media in your own teaching?

26. Motion Pictures
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

27. Television
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

28. Overhead Projection Transparencies
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

29. Audio Tape Recordings, Records, or Radio
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

30. Slide Programs
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

31. Filmstrips
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

32. Models or Specimens
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

33. Games
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

34. Charts, Graphs, Posters, Bulletin Boards
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

35. Chalkboard
Not at all 0 1 2 3 4 5 6 7 8 9 Extremely often

MEDIA PRODUCTION SKILL SCALE (MPSS)

Ratings: 1) Very poor, 2) poor, 3) fair, 4) good, 5) very good.

Dry Mount

Task: To mount a visual on a 11 x 14 inch piece of illustration board using dry mount tissue.

Criteria:					
Placement of visual on board	1	2	3	4	5
Trimming of visual	1	2	3	4	5
Dry mount tissue visible from edges of visual	1	2	3	4	5
Bubbles and creases	1	2	3	4	5
Permanency of mount	1	2	3	4	5
Dirt on board and visual	1	2	3	4	5
Overall appearance	1	2	3	4	5

Rubber Cement Mount

Task: To mount a visual on a 11 x 14 inch piece of illustration board using the permanent rubber cement technique.

Criteria:					
Placement of visual on board	1	2	3	4	5
Rubber cement blemishes	1	2	3	4	5
Rubber cement left on margins and surface of visual	1	2	3	4	5
Dirt or foreign matter under visual or on mount board	1	2	3	4	5
Trimming of visual	1	2	3	4	5
Tightness of adhesion	1	2	3	4	5
Overall appearance	1	2	3	4	5

Commercial Lettering

Task: To letter a set of given words so that the letters are properly spaced using dry transfer letters.

Criteria:					
Letter alignment	1	2	3	4	5
Neatness of letters	1	2	3	4	5
Line spacing	1	2	3	4	5
Word spacing	1	2	3	4	5
Overall appearance	1	2	3	4	5

Mechanical Lettering

Task: To letter a set of given words so that the letters are properly spaced using a letter guide and pen or brush.

Criteria:					
Letter alignment	1	2	3	4	5
Neatness of letters	1	2	3	4	5
Spacing between letters	1	2	3	4	5
Smoothness of ink	1	2	3	4	5
Line spacing	1	2	3	4	5
Overall appearance	1	2	3	4	5

Hand Lettering

Task: To letter a given phrase so that the letters are properly spaced using the speedball pen technique.

Criteria:					
Letter alignment	1	2	3	4	5
Neatness of letters	1	2	3	4	5
Letter spacing	1	2	3	4	5
Word spacing	1	2	3	4	5
Line spacing	1	2	3	4	5
Smoothness of ink	1	2	3	4	5
Overall appearance	1	2	3	4	5

Illustration - Squared Reduction

Task: To reduce a given illustration using the squared reduction method. A finished pen and ink drawing is required.

Criteria:					
Accuracy of reduction	1	2	3	4	5
Smoothness of line	1	2	3	4	5
Finished appearance	1	2	3	4	5

Illustration - Projected Enlargement

Task: To enlarge a given illustration using the opaque projector. A finished pen and ink drawing is required.

Criteria:					
Accuracy of enlargement	1	2	3	4	5
Smoothness of line	1	2	3	4	5
Finished appearance	1	2	3	4	5

Display

Task: To create a bulletin board display no smaller than 20 x 32 inches which is directed toward a learning objective and a particular audience.

Criteria:

Content

Does the content suit the audience	1	2	3	4	5
Does the content suit the objective	1	2	3	4	5
Is material logical and understandable	1	2	3	4	5
Free of irrelevant material	1	2	3	4	5

Design

Durability of materials	1	2	3	4	5
Originality of design	1	2	3	4	5
Neatness of design	1	2	3	4	5
Simple without jeopardizing components	1	2	3	4	5
Is the design balanced	1	2	3	4	5
Is the message or central theme emphasized	1	2	3	4	5
Is there sufficient contrast	1	2	3	4	5
Is the design harmonious	1	2	3	4	5
Is the design unified	1	2	3	4	5
Is there too much or too little negative space	1	2	3	4	5
Do the verbal messages support the visual statement	1	2	3	4	5
Is the lettering size and style appropriate	1	2	3	4	5
Is the lettering legible (spacing & contrast)	1	2	3	4	5
Are the illustrations executed well	1	2	3	4	5
Are the mounting techniques smooth and straight	1	2	3	4	5
Overall appearance	1	2	3	4	5

REFERENCES

Brookens, L. An exploratory study of media instruction of preservice and inservice teachers at Oklahoma State University based on analysis of their media competency and utilization. (Doctoral dissertation, Oklahoma State University, 1970) Dissertation Abstracts International, 1970, 5145-A.

Busse, N. L. Revealed how classroom teachers use media. Audiovisual Instruction, 1976, 21(8).

Dunathan, A., & Powers, W. Educational media among three levels of communication apprehensive beginning education majors. Educational Communications and Technology Journal, 1979, 27(1).

Ford, M. D. An exploratory study of media competencies as perceived by 1973 teacher graduates from the University of Oklahoma and other selected teacher education institutions in Oklahoma. (Doctoral dissertation, University of Oklahoma, 1974). Dissertation Abstracts International, 1974, 5676-A.

Fulton, W.R. Audio visual competence and teacher preparation. Journal of Teacher Education, 1960, 11(4).

Haselwood, E. L. An analysis of the media competencies of college of education student teachers at the University of Nebraska at Omaha. (Doctoral dissertation, University of Nebraska-Lincoln, 1972). Dissertation Abstracts International, 1972, 201-A.

Kennard, A. L. Media competency of teachers in relation to the quality of educational media programs in teacher training institutions: a study of selected Louisiana public institutions and graduates. (Doctoral dissertation, University of Oklahoma, 1973) Dissertation Abstracts International, 1973, 1753-A

King, R. A study of selected factors related to variability in the use of certain types of instructional media among teachers. Unpublished doctoral dissertation, University of Missouri, 1967.

McCroskey, J. C. Measures of communication-bound anxiety Speech Monographs, 1970, 38, 210-277.

McCroskey, J. C. and Anderson, J. F. The relationship between communication apprehension and academic achievement among college students. Human Communication Research, 1976, 3(1), 73-81.

McCroskey, J.C. Oral communciation apprehension: a summary of recent theory and research. Human Communication Research, 1977, 4(1), 78-96.

Meierhenry, W.C. Media competencies for teachers in the use of newer media and various approaches to achieving them. 1966. (ERIC Document Reproduction Service No. ED 012 713).

Meierhenry, W.C. Teacher competencies project, Audiovisual Instruction, 1967, 12(10), 1030-1.

Pascoe Report. Audiovisual Instruction, 1957, 4(1).

Powers, W., & Dunathan, A.T. The effect of educational level and communication apprehension upon projected instructional media utilization. Paper to be presented at the International Communication Association conventio, Chicago,1979.

Romano, F. A.,& Speiker, J. Educational media competencies for future secondary school teachers: a comparative study of views held by secondary school principals and academics. 1974. (ERIC Document Reproduction Service No. ED 111 794).

Salley, H. Ohio Survey. Audiovisual Instruction, 1965, 10(7).

Streeter, E.C. Teacher competency and classroom use of educational media. Audiovisual Instruction, 1969, 14(1).

White, Frederick. Teacher competence in the use of audiovisual material. AVCR, 1953, 1, 91-98.

TITLE: Implications of a Gestalt Approach to Research in Visual Communications

AUTHOR: Ann Becker

Implications of a Gestalt Approach to Research in Visual Communications

Ann Becker
University of Wisconsin-Madison

Presented at the Annual Convention of the Association for Educational Communication and Technology, Denver, April 1980.

The success of behaviorism in the social sciences has depended, in large part, on a researcher's belief in his or her ability to isolate thought processes and to measure, with a fair amount of certainty, the products of thought. But if you believe, as does Suzanne Langer (1967) that thinking is an act which proceeds in fits and starts and is variously informed by such mental functions as memory, imagination and will, than the stimulus response paradigm looses some of its explanatory power. If you take an additional step and believe that imaging plays a major role in the act of thinking, you are confronted with another mental function that often defies isolation and measurement. Consider what psychologist Edward Titchner (in Arnheim, 1969) said in 1909 about imaging and thinking.

"My mind, in its ordinary operations, is a fairly complete picture gallery, not of finished paintings, but of impressionist notes. Whenever I read or hear that somebody has done something modestly, or gravely, or proudly or humbly or courteously, I see a visual hint of the modesty or gravity or pride or humulity or courtesy. The stately heroine gives me a flash of a tall figure, the only clear part of which is a bowed back."

In Titchner's view, image formation in the act of thinking is impressionistic. He would agree, I believe, with Langer that the functions of thought do not yield to isolation and measurement. Yet, Titchner's images have meaning which can still be communicated today. The combined words 'stately heroine' 'tall figure' 'steely grey skirt' allow us to form our own images and meaning is then communicated in a situated sense. The image created, the picture in your mind, has in its entirety stimulated the formation of a concept.

One learning theory that deals with the act of thinking and the construction of concepts in a situated manner is Gestalt theory. Another word for Gestalt is form. Notice that Titchner's image was largely understood because of its form, because of what was included within the frame of his mental picture and what was excluded. Some psychologists who have long been confronted with the problem of accounting for haphazard imaging functions of the mind have applied gestalt theory. It has at various times been a favored paradigm in perception research. It does not force a researcher to isolate and measure mental functions, such as imaging, but allows him or her to consider them in a situated sense, as part of a whole.

In asking perceptual questions, gestaltists have explored the ability of the mind to organize haphazard information both visual and non-visual. The mind, they tell us, organizes visual information because of relationships between objects. Such relationships have been divided into categories of similarity, continuity, proximity and closure. The key words for gestaltists are form and meaning. The mind, they believe, extracts meaning by interpreting the form cues which are present in a visual display (Wilson, et. al., 1969). I would like to refer to those form cues as the smallest units of meaning in a visual display. Gestaltists believe, then, that we read these form cues. The ability of a viewer to read or decipher figure ground relationship is primary in distinguishing essential and incidental information. The ability of a viewer to compare and contrast shapes employs the gestalt principles of similarity and proximity. The ability of a viewer to fill and correct shapes employes the gestalt principles of continuity and closure. Additional perceptual skills are needed, gestaltists point out, to interpret form and color constancy, size scaling, figure ambiguity and line alternation (Bloomer, 1979). Placement of the figure allows the viewer to exercise viewpoint and orientation skills. It is important to note that the smallest units of meaning, the form cues, are contained in the visual display itself. The mind in interaction with those units extracts meaning, so that the intuitive moment of conceptualization is less one of discovery and more one of interaction between mental skills and form cues. Current visual communication research employing gestalt principles either theoretically or methodologically have helped subtract some of the "aha" from the intuitive moment of conceptualization.

Since the founding of the gestalt school of psychology by Wertheimer in the early 20's, stress has been placed on insightful learning (Wilson, et. al., 1969). Insight, in fact, was emphasized in the interpretation of the work Kohler and Yerkes with primates. Focus was placed on the discovery aspects of the chimpanzee's and gorilla's behavior. Yet, Yerkes himself discusses the steps which preceed insight. He describes first, a survey of the situation or display; second , hesitation and concentrated attention; third, trial and error; fourth, recurrent concentrated attention; and fifth, finally performance and repetition (in Wilson, et. al., 1969). Note that his concern was with the outward behavior of the gorilla. From that behavior or motion, to be exact, he had to extrapolate the process of insightful learning. In that early stage of Gestalt research, he did not ask questions about the first and second steps, namely survey and attention that have been subsequently asked. One might have asked "as the gorilla surveyed the display, what form cues gave him the information he needed to proceed and which cues riveted his attention and facilitated his extraction of meaning from the situation."

Current visual communications researchers do ask such questions (usually not of gorillas); they ask questions about how viewers extract meaning from the form and content of visual displays. Those researchers who address themselves to questions of form and meaning, whether it is an investigation of obvious gestalt principles such as figure/ground, closure, proximity or an exploration of structure, codes, aesthetics or grammar of visual displays are employing gestalt theory. The central question is one of seeking the extraction of meaning from a visual display.

A popular way of defining the patterns which emerge from application of form cues in a visual display is to call these patterns codes (Barthes, 1977). Codes carry some of the infrastructure of a picture, but before I discuss codes, I would like to talk about those form cues that gain our attention. Researchers dealing with visual displays are often stymied by the amount of information within a frame. Methods for recording thousands of bits of information created by form cues appear almost impossible. Yet, the people who create the visual displays, the artist, the photographer, the camera person, apply those form cues daily. They understand the patterns or codes of those cues, whether their understanding is intuitive or realized. To get inside each medium, to study the patterns of usage would help unpack some of the vital information about form cues and their relation to meaning. The task may still appear impossible, but patterns would be studied within the context of a question or hypothesis. (I will later describe some studies which do this.) Units of form or structure which communicate meaning in a visual display have been identified in art, photography and film as well as other visual media. Some of these cues are frame, line, color and shape. Rudolf Arnheim in Art and Visual Perception (1969) lists ten within a frame and John Kennedy (1974) lists seven methods of line representation to depict surface within a frame. In photography, borrowed, as well as unique cues are important. Some of them are frame, focal point, proximity, angle of approach and depth perception. Eleanor Gibson (1969) in her seminal work in perception stressed the importance of these form cues to the interpretation of photographs. Additional form cues are found in the creation of motion visuals. Cues operate in film and TV on three moving planes, the plane of the image, the plane of the geography of the space photographed and the plane of depth perception (Monaco, 1977). Problems of describing patterns of overlapping, convergence, relative size and density gradient become more complex. Problems of describing patterns unique to motion, cues such as panning, tilting, zooming and dollying; and switches such as cuts, fades, dissolves and superimpositions are not as complex.

We not only know form cues are present within a frame, but we know how we read them. We know that the bottom is more important than the top, that the left side of the frame is read first and that the bottom is stable and the top unstable (Monaco, 1977).

Description of these form cues in visual media such as art, photography, and film have been available to us for some time and it has been traditional in aesthetic and literary criticism to study the contribution of form to meaning. What has not been carried out in either the humanities nor the social sciences is a systematic description of the patterns of usage, in other words, the codes, in various visual media. I believe that with current micro computer technology this can be accomplished. For instance, the pattern of usage, or the code for plot development varies from theater to cinema to television. A study which compares and contrasts the usage of plot development in these three visual media would accomplish two things. First, it would allow us to evaluate the contribution of codes from theater and film to TV, and secondly, it would allow us to describe the unique contribution of TV to plot development. Consider similar comparative analysis to uncover the codes of suspense used in art, photography and film or the codes of dialogue suggested by photography and applied in film and television. Such comparisons would yield a clearer understanding of the unique visual characteristics of these media.

Calls for the study of coding in visual media have come recently from Wilbur Schramm (1977), Gavriel Salomon (1979), and Howard Levie (1978) among others. In his work on symbolic codes, Levie discussed the relationship between pictorial codes and mental operations and suggests that future visual literacy study focus on this relationship.

Suggestions for the study of coding, however, have been borrowed from the area of semiotics, which has been called a general science of treating "sign systems". (deSaussure, 1966). Since visual media are generally thought to be sign systems they are ripe for semiotic analyses. This analysis attempts to describe the unknown parameters of a sign system, such as photography, by close observation of the existing medium (Barthes, 1977). Basic objectives of this type of anlaysis call for a logical description of the codes and signs that give meaning to the system. These codes and signs must be observed from the inside of the existing medium. One must understand how they are used and what they contribute to the whole system. Some current semiological research in the visual media has been carried on by Metz (1974) and Bettitini (1973) in cinema, by Umberto Eco (1976) in television and by Roland Barthes in printed text and other media (1977). Each of these researchers, if they may be so called, are structural analysists, following a time honored literary tradition of "reading text". In most cases here they give readings of media and describe with precision their meaningful units. Social scientists have long eschewed the methods subjective criticism, in which these analysists engage because it does not provide verification nor generalizability. Semiotic theory, however, is too rich for us to ignore. Methods of observation already established in the social sciences can be applied, I believe to semiotic analysis.

Given the problem of comparing specific codes among two or three visual media, observation techniques could be developed. Form cues could be categorized and prioritized and then submitted to a panel of experts for a validity check. Observers could be given similar training to reduce bias. Computer assisted programs could be written for the observers to check the appearance, frequency and duration of form cues.

Observers could analyze with the assistance of the computer the same medium at the same time and a reliability check could be run on their recording. Finally, patterns or codes would emerge and again the computer could help not only with the analysis but with visual displays of these codes.

Analysis of codes and their contribution to the meaning in visual media is only one part of semiotic analysis, but is the only aspect of that analysis that I am addressing here. It must be understood that codes only exist within and because of a communication. It would be foolish to study the pattern of shots (long, medium, close up) which emerge in a random selection of film or TV. Yet, to study the patterns which emerge when suspense, or plot advancement, or dialogue occur would net meaningful information. Those studies which deal with coding or unpacking meaning through the study of form, I have loosely classified as Gestaltists studies. Some current theorists and researchers address coding issues in various visual media. In 1975 Zakia (1975) suggested the use of some classic gestalt principles namely similarity, proximity, closure, and continuity, as codes in photography.

A current study in progress at the University of Wisconsin-Madison investigates the concept of closure as a code in photography.

Niko Metallinos (1979) in his recent article on television suggests the study of asymmetry, main direction, magnetism, attraction of mass, figure/ground relationship, closure and vectors as codes operating within the TV frame.

Television is also the subject of two current studies at the University of Wisconsin-Madison. One study is attempting to describe the codes used in the audio track of TV news programs while the other is considering plot codes present in TV drama.

Additional hypotheses can and have been posed about visual codes used by novices in production. Howard Levie has indicated the desirability of such an approach when he said that "even though the ability to interpret a code is not usually dependent upon being able to produce it, production may be an excellent avenue to a richer understanidng of the process" (Levie, 1978, p. 34). Worth and Adair (1972) in a now famous study with Navajo Indians asked questions about which compositional style novices would use when asked to tell a story with film. They found that native narrative styles used to tell existing Navajo myths and stories emerged in film composition. In fact certain grammatical structures were transferred intact to film composition. It was disclosed then that codes of storytelling, narrative codes that were embedded in Navajo tradition, dominated the new medium. Codes from another medium (storytelling) supplied some of the infrastructure of the new medium, film.

A study similar to the Worth and Adair study was conducted by ethnomethodologists Beryl Bellman and Bennetta Jules-Rosette (1977) in Africa. They asked approximately the same questions of natives selected from two African communities in Liberia and Zambia. Questions about compositional style of novices were posed. Video cameras were given to the selected participants who then created their own stories on tape. Traditional narrative codes which appear in the oral literature of both of these tribes were transferred to the composition of videotape. As with the Navajo's, their compositional style was narrative. When Bellman and Jules-Rosette conducted this same study, by the way, with American TV production novices, it was found that their dominant compositional style was dramatic, not narrative. The value to us, however, of both the Navajo and African studies can be found in the methods. Both studies developed methods for reading motion visuals, for describing form cues and their patterns of usage, their codes. In fact, Bellman and Jules-Rosette gave a detailed reading of the motion cues contained in the narrative style of videotaping. Patterns which emerged on the tapes were extensive use of panning for establishing shots, slow panning throughout, an absence of zooms (wheras Americans used the zoom), use of dollying and use of hesitations. What they are describing for the first time are codes of narration in documentary videotape.

I have attempted here to suggest a research method for the analysis of form cues and their codes in visual media. Descriptions of patterns which emerge from observation of these existing visual media will, I believe, allow us not only to articulate the contricution of codes to the meaning of the visual communication, but will give us more control over the proper design of visuals for communication with these media.

Bibliography

Arnheim, R. Visual Thinking. Berkeley: University of California Press, 1969.

Barthes, R. Elements of Semiology. Translated by Annette Lavers and Colin Smittz. New York: Hill and Wang, 1977.

Bellman, B. and Jules-Rosette, B. A Paradigm for Looking: Cross Cultural Research with Visual Media. Norwood, N.J.; Ablex Publishing Corp., 1977.

Bettitini, G. The Language and Technique of the Film. The Hague: Mouton, 1973.

Bloomer, C. Principles of Visual Perception. New York: Litton Ed. Publishers, 1976.

de Saussure, F. Course in General Linguistics 1906-1911. New York: McGraw-Hill, 1966.

Eco, U. A Theory of Semiotics. Bloomington: University of Indiana Press, 1976.

Gibson, E. Principles of Perceptual Learning and Development. New York: Merideth Corp., 1969.

Kennedy, J. M. A Psychology of Picture Perception, San Francisco: Jossey-Bass, 1974.

Langer, S. K. Mind: An Essay on Human Feeling (Vol. 1). Baltimore: The Johns Hopkins Press, 1976.

Levie, J. "A Prospectus for Research on Visual Literacy" ECTJ, Vol. 26 No. 1 Spring 1978, pp. 25-35.

Metallinos, N. "Composition of the TV Picture. Some Hypotheses to Test the Forces Operating Within the Television Screen." ECTJ. Vol. 27, Fall 1979, pp. 205-214.

Metz, C. Film Language: A Semiotics of the Cinema. Translated by Michael Taylor. New York: Oxford University Press, 1974.

Monaco, J. How to Read a Film. New York, Oxford University Press, 1977.

Olson, D. E. (ed.) Media and Symbols. Seventy-third Yearbook of the National Society for the Study of Education; Chicago, University of Chicago Press, 1974.

Schramm, W. Some Notes on Research, Theory and Production in Instructional Television. Agency for Instructional Television, 1977.

Solomon, G. Interaction of Media Cognition and Learning. San Francisco, Jossey-Bass Publishers, 1979.

Wilson, J. A. R., Robeck, M. C., Michael, W. B., Psychological Foundations of Learning and Teaching. New York; McGraw-Hill, 1969.

Worth, S. and Adair, J. Through Navajo Eyes: An Exploration in Film Communication and Anthropology. Bloomington: Indiana University Press, 1972.

Zakia, R. D. Perception and Photography. Englewood Cliff, N.J., 1975.

TITLE: Research on Pictures and Instructional
Texts: Difficulties and Directions

AUTHOR: Philip J. Brody

RESEARCH ON PICTURES AND INSTRUCTIONAL TEXTS: DIFFICULTIES AND DIRECTIONS

Philip J. Brody
Assistant Professor, Curriculum and Instruction
Director, Educational Media Laboratory
University of Kansas

Paper presented to the Annual Meeting,
Association for Educational Communications and Technology
Denver, Colorado, April 21-25, 1980

Abstract

Although pictorial illustrations are one of the most common components of instructional texts, little has been done to determine how they affect learning from texts. The research associated with this area is characterized by a diversity of purpose, approach, and methodology. Among the most common problems are the utilization of materials, both verbal and pictorial, which are not representative of materials found in instructional texts, an emphasis on how pictures help learning to read rather than how they help learning from reading, a lack of diversity of instructional content, and a general lack of attention to the theoretical aspects of the problem.

To gain a more complete understanding of how pictures affect learning from text it will be necessary to encourage researchers to focus their attention on more immediately practical problems. This may call for the development of a new type of researcher, one who has both traditional research skills, as well as the concerns of the instructional development specialist. Additionally, it will be necessary to focus on pictorial attributes rather than on the entire picture.

INTRODUCTION

Instructional texts are probably found in more schools than any other type of instructional media. Instructional texts are usually characterized by both written words and symbols as well as various types of pictorial and visual illustrations. Yet, in spite of the fact that there has been considerable research in related areas such as the effect of pictures on learning to read both individual words and passages, surprisingly little is known about the effect of pictures on learning from instructional text. As a matter of fact, the term "instructional text" is often confounded with other types of instructional books. In this paper it will refer only to those books whose primary purpose is to present subject-specific information and techniques, rather than those books, such as basal readers, whose objectives are generally free of the constraints of specific academic subjects.

Unfortunately, once this distinction is made, it becomes quite apparent that research in this area is characterized by a diversity of purpose, approach, and methodology. The following then is an attempt to describe the difficulties associated with research which attempts to determine the relationship of pictorial illustrations and learning from instructional text, and to indicate some directions needed to be taken in order to provide useful results.

Difficulties

One of the major difficulties associated with determining the effect of pictorial illustrations on learning from instructional texts has been a continued emphasis on studying how pictures affect learning to read rather than examining how pictures affect learning from reading. As a result, there are numerous studies of the former type with only rare examples of the latter. The problem then feeds upon itself as evidenced by reviews of research which continue this emphasis. Samuel's (1970) oft cited review, for example, concentrates on the effect of pictures on acquisition of sight vocabulary while paying only slight attention to how they affect comprehension of verbal materials. The few results cited by Samuels which deal with comprehension indicate that pictures do not hinder comprehension; however, even these conclusions are confounded by the fact that the sources cited used materials that were more representative of passages used in training students to learn how to read rather than as subject-specific instructional materials. Conclusions and methodology similar to Samuels were also found in another review of research, Concannon's (1975) analysis of the role of pictures in the reading process.

The use of pictorial stimulus materials which are not representative of those found in instructional text is another common problem in picture-text research. Peeck (1975), while concluding that pictures help increase the amount of information acquired, incorporated a reading passage into cartoon-like illustrations. Similarly, using young children, Haring and Frye (1979) and Ruch and Levin (1977) based their conclusions on studies which used simplified line drawings rather than the more replete illustrations found in texts. The problem of making generalizations from studies using inappropriate illustrations is also found in studies which used older learners and which do focus on learning from reading. Line drawings which were not representative of those found in texts were used by Royer and Cable (1976); computer generated graphics were used with college students by Rigney and Lutz (1976) who concluded that pictures can help concept acquisition from verbal material.

Just as results are confounded by utlizing pictures not representative of those found in instructional texts, so too are the results confounded by the verbal component of experimental treatments. One such manifestation of this problem is the use of passages which are too short. Rankin and Culhane (1970), for example, used a 250 word passage as the treatment for college students. Similarly, Koenke and Otto (1969) required third and sixth grade students to read passages of only 198 words in length, even though they had probably been exposed to longer passages in instructional texts. The use of verbal materials that are more indicative of basal readers than instructional texts are often found in those experiments which utilize elementary level students. Verbal treatments which use narrative and prose styles of writing rather than the expository style usually found in instructional texts (e.g., Haring & Frye, 1979) are the rule rather than the exception.

Other research variables are similarly suspect. Reading passages and their accompanying pictorial illustrations are often presented in ways which barely resemble the manner in which they are typically used in instructional texts. Presenting stimulus materials by slides (Rohwer & Harris, 1975) only loosely approximates the manner in which instructional texts are read: turning back to review, if allowed, is difficult; psychomotor differences between turning a page and operating a project can confound, as can the perceptual difference between reading project and non-projected images; size and distance of images differ. Similarly, presenting the stimulus materials in a computer assisted instruction format presents an artificial treatment which makes accurate and meaningful interpretation difficult.

The lack of diversity of content presents another example of difficulties encountered when trying to determine how the use of pictures can effect learning from instructional text. For the most part, the content has been based on science and mathematic instruction. Dwyer's (1971) study was based on the functioning of the human heart; passages on heat flow and electrical conductivity were used by Royer and Cable (1976); mathematical concepts were the content of the Rasco, Tennyson, and Boutwell (1975) study. While science and mathematics are certainly valid subjects for instructional inquiry, they represent only a partial, and similar, sample of the content and techniques studied in modern schools. Even at the elementary school level, students are exposed to instructional texts in such diverse areas as language arts, social studies, health, and communications. While each of these may require learning skills which differ considerably from those needed to master science and/or math, with few exceptions they have been ignored by media research.

Still other conditions abound which increase the difficulty in extracting useful information about the relationship between pictorial illustrations and learning from instructional text. For example, rather than focusing on how pictures influence learning from text, Snowman and Cunningham (1975) had subjects actually draw pictures after reading a pictureless passage. While artificial manipulations such as this may be appropriate for imagery studies, they hardly represent the conditions found in current educational practice.

Another such condition centers on the number of pictures that are found in a reading passage. Whereas texts usually have a limited number of pictures, particularly at more advanced levels, several studies have been used an inordinately large number of pictures. In Dwyer's (1971) study, college students viewed thirty-seven visuals in a 2000 word passage, approximately one visual for every 54 words; in the Rankin and Culhavey (1970) study, subjects viewed seventeen visuals in a 250 word passage, approximately one visual for every fifteen words. Utilization of materials with such low picture/word ratio not only raises serious questions of external validity, but also demonstrates a lack of concern for appropriate pedogogical techniques.

The continued emphasis on the gross media comparison tradition also makes the identification of information relevant to the relationship between pictures and learning from text more difficult. With few exceptions, the majority of students have examined the pictorial illustrations and reading passages as discrete invariant wholes rather than as units consisting of various attributes. This then leads to the predominance of studies which compare learning from passages that include pictures to passages without pictures. Peeck (1974) compared passages that included cartoon illustrations to passages without such illustrations. A somewhat more complex, but similar, approach was used by Main and Griffiths (1977) who compared various combinations of pictorial, print, and audio stimuli. Similarly, Jahoda et. al. (1976) compared text only, simple line drawings, and a combination of the two. While these studies at least made some attempt to describe the nature of the visuals utilized, other studies failed to mention even this minimal consideration.

As can be seen, the above studies neither compared different pictorial attributes, nor did they compare similar types of visual formats. Instead, they seem to focus on determining if pictures, whatever is meant by the term, help increase learning from text, rather than determining which pictorial components or attributes help learning from instructional text. Although this approach has been criticized with a fair degree of regularity (e.g., Allen, 1971; Salomon & Clark, 1977; Torkelson, 1977), picture-text research has only sporadically followed this advice.

Although there are instances where the effectiveness of pictorial attributes are compared (e.g., Thomas, 1978; Dwyer, 1971) these studies share certain similarities. First, the basis for comparison is usually the visual's physical and/or perceptual characteristics such as color and fidelity. Second, the theoretical considerations are generally limited to the realism continum, a concept which research has continually suggested has only limited utility as a predictor of learning (Dwyer, 1978, 1972). Third, there has been an emphasis on outcomes dealing with either the transfer and replication of information or attitude change rather than how pictorial attributes affect behavioral outcomes. Fourth, most of the studies which have compared pictorial attributes have attempted to answer questions related to whether or not pictures help increase learning while neglecting more recent conceptualizations (e.g., Levie, 1978) which emphasize how different pictorial attributes affect learning.

Directions

It is quite difficult to determine future trends in picture-text research. While there seems to be an increasing interest in studying the various effects of pictures, there has been a general lack of hard disciplined research on how learning from instructional texts is affected by various types of pictures and pictorial attributes. In addition to some of the difficulties mentioned previously, the research in this area is characterized by one-shot studies, where researchers seem to abandon the area after reporting only one study.

However, it is this general increase in pictorial research which may result in more picture-text studies, for as more individuals become concerned with the effect of pictures on other types of learning there may be a corresponding increase in this neglected area. Additionally, current economic conditions require research to be more applicable to practioners. Since instructional texts are one of the most common forms of instructional media, this trend may result in increased attention to the picture-text relationship. However, the general tendency to resist change may make it necessary to look in other directions for solutions to this and similar problems. A potential source may be the development and legitimazation of a new breed of researchers who, in addition to the traditional research skills, have the background and concerns of the instructional design specialist.

Increasing the number and/or focus of concerned researchers represents only part of the solution, for it is also necessary to examine the effects of pictures on instructional text in a broader context. More attention, for example, needs to be paid to the identification and description of those pictorial attributes being examined, thereby increasing the precision of research. This in turn will enable time and energy to be spent where it will do the most good. On the other hand, a continuation of current research methodologies will only suggest that there is something in some pictures which increase learning from instructional text.

The selection of pictorial attributes studied needs to be expanded from the narrow realism perspective to approaches that will provide more useful and applicable information. While somewhat useful, the realism approach often distracts from utilizing and examining variables which may be more directly related to the effect of pictures on learning from instructional text. An alternative approach would not examine isolated attributes such as color or fidelity, but would examine variables in terms of their relationship to instructional text. Hartley (1979), for example, suggested that while location of a picture within a passage may have important consequences, it has rarely been studied. Other, similar concerns include the need to determine the optimum number of pictures per passage and the relationship of different types of pictures to different types of content.

Another approach would first determine how pictorial variables function and then compare these functional characteristics to other pictorial and non-pictorial variables which function in a similar manner. For example, if a particular pictorial variable functions as a device which encourages students to review previously read materials, then it can be compared to other non-pictorial variables which function in a similar manner (e.g. questions). Thus, the ability to generalize from other mediums and instructional techniques is increased, resulting in expanded utility of research efforts.

Future research must also begin to pay more attention to how pictures affect instructional outcomes other than those related to the transfer and replication of knowledge. For example, the need for instruction to affect the development of the various internal or mental skills has been suggested by those directly involved with media research (e.g., Levie, 1978) as well as those whose primary concern is in other areas of instruction (e.g., Gagne, 1974).

Perhaps the most prominent advocate of this approach is Salomon (1979), who has not only theorized that various media attributes or symbol systems can affect covert mental behavior, but has also provided some empirical proof to support his contentions. More specifically, he has indicated that the various symbol systems employed by different mediums vary as to the type of mental skills they require the student/receiver to utilize and that these symbol systems can be used to activate these skills in students who already possess them or can supplant the skills in learners who do not. Applying Salomon's conceptions to the picture-text relationship could lead to added precision in the design of instructional text. For example, Brody and Legenza (1980) have suggested that pictures placed after a reading passage can encourage students to review previously read information.

As greater emphasis is placed on individualized instruction and on providing a first class education to an increasingly heteorogeneous population approaches such as these have the potential to profoundly influence instructional materials design.

References

Allen, W. H. Instructional media research: Past, present, and future. AV Communication Review, 1971, 1971, 19, 9-18.

Brody, P. J. and Legenza, A. Can pictorial attributes serve mathemagenic functions? Educational Communication and Technology Journal, 1980, (in press).

Concannon, S. J. Illustrations in books for children: Review of research. The Reading Teacher, 1975, 29, 254-256.

Dwyer, F. M. An experimental evaluation of the instructional effectiveness of black and white and colored illustrations. Didakta Medica, 1971, 3, 96-101.

Dwyer, F. M. A Guide for Improving Visualized Instruction. State College, Pa.: Learning Services, 1972.

Dwyer, F. M. Strategies for Improving Visual Instruction. State College, Pa.: Learning Services, 1978.

Gagne, R. M. and Briggs, L. J. Principles of Instructional Design. New York City: Holt, Rinehart and Winston, 1974.

Hartley, J. Designing Instructional Text. New York City: Nichols, 1979.

Jahoda, G. et. al., Utilization of pictorial information in classroom learning. AV Communication Review, 1976, 24, 195-315.

Koenke, K. and Otto, W. Contribution of pictures to children's comprehension of the main idea in reading. Psychology in the Schools, 1969, 6, 298-302.

Levie, W. H. A prospectus for research on visual literacy. Educational Communication and Technology Journal, 1978, 26, 25-36.

Main, R. E. and Griffiths. Evaluation of audio and pictorial instructional supplements. AV Communication Review, 1977, 25, 167-179.

Peeck, J. Retention of pictorial and verbal content of a text with illustrations. Journal of Educational Psychology, 1974, 66, 880-888.

Rankin, E. F. and Culhane, J. W. One picture worth 1000 words? Reading Improvement, 1970, 7, 37-40.

Rasco, R. W., Rennyson, R. D. and Boutwell, R. C. Imagery instructions and drawings in learning prose. Journal of Educational Psychology, 1975, 67, 188-192.

Rigney, J. W. and Lutz, K. A. Effect of graphic analogies of concepts on chemistry learning and attitude. Journal of Educational Psychology, 1976, 68, 305-311.

Rohwer, W. D. and Harris, W. J. Media effects on prose learning in two populations of children. Journal of Education Psychology, 1975, 67, 651-657.

Royer, J. M. and Cable, G. W. Illustrations, analogies, and facilitative transfer in prose learning. Journal of Educational Psychology, 1976, 68, 205-209.

Ruch, M. D. and Levin, J. R. Pictorial organization versus verbal repetition of children's prose: Evidence for processing differences. AV Communication Review, 1977, 25, 269-280.

Salomon, G. On the future of media research. Educational Communication and Technology Journal, 1978, 26, 37-46.

Salomon, G. Interaction of Media, Cognition, and Learning. San Francisco, Jossey-Bass, 1979.

Salomon, G. and Clark, R. E. Reexamining the methodology of research on media and technology in education. Review of Educational Research, 1977, 47, 99-120.

Samuels, S. J. Effects of pictures on learning to read, comprehension, and attitudes. Review of Educational Research, 1970, 40, 397-407.

Snowman, J. and Cunningham, D. J. A comparison of pictorial and written adjunct aids in learning from text. Journal of Educational Psychology, 1975, 67, 307-311.

Thomas, J. L. The influence of pictorial illustrations with written text and previous achievement to the reading comprehension of fourth grade science students. Journal of Research in Science Teaching, 1978, 15, 401-405.

Torkelson, G. M. AVCR--One quarter century: Evolution of theory and research. AV Communication Review, 1977, 25, 317-358.

TITLE: The Effects of Three Levels of Visual Complexity on the Information Processing of Field-Dependents and Field-Independents When Acquiring Instructional Information for Performance on Three Types of Educational Objectives

AUTHOR: James J. Canelos

The Effects of Three Levels of Visual Complexity on the Information Processing of Field-Dependents and Field-Independents When Acquiring Instructional Information for Performance on Three Types of Educational Objectives*

Prepared By

James J. Canelos, Ph.D.
The Pennsylvania State University

---

*This study was conducted by William Taylor, Ph.D., Assistant Professor, Ohio State, and James J. Canelos, Ph.D. during fall term 1979 at Ohio State University.

Introduction

The present study examined the effects of three levels of visual complexity upon the learning of an instructional slide-tape program about the functions of the human heart. Levels of visual complexity formed the visual portion of the slide-tape instructional program. The three complexity levels were: (1) a simple line drawing in color, (2) an illustration in color, (3) a realistic color photograph. A second area of interest in this study was the effects of visual stimulus complexity upon the information porcessing of field-dependents and field-independents. The learning (information processing) of each level of this cognitive style was also examined on three levels of educational objectives or learning outcomes, ranging from: (1) simple list learning, to (2) spatial learning, and, finally (3) conceptual learning.

Rationale and Literature

The individual difference variables in the form of cognitive styles have a major effect upon how the learner will process instructional material of a visual nature. The cognitive style is pervasive throughout all school learning and life problem solving activities (Cross, 1976). A cognitive style operates much like the executive program operates in the computer. The cognitive style forms a metaplan system, or a set of super plans the person must put into operation when it is time for him or her to learn, solve a problem or simply day dream (Miller, G.A., Galanter, E. and Pribram, K.H., 1960). In other words, the particular cognitive style the person uses actually determines how the individual will psychologically differentiate, or "see and record" the stimuli in his or her environment. This means that the reflective style will see an environmental stimuli differently than an impulsive cognitive style (Harvey, Hunt and Schroder, 1961); or that a cognitively complex style will see a group of concepts to-be-learned quite differently than the cognitively simple style (Bier, 1961; Kelly, 1955). The construct of cognitive styles has tremendous implications for those involved with the design of learning materials and instructional programs. This is pointed out by Dwyer (1978) when he cites as a critical area of research the following:

> the investigation of . . . . What specific individual difference variables interact disordinally with different types of visual illustrations for specific educational objectives. (p. 20)

The formation psychologically of one cognitive style or another seems to be a function of the interaction between the person's genetic characteristics and environmental occurrences occurring during maturation. Once formed, the particular style of differentiating environmental information is quite "hard and fast" and not likely to change. Therefore, it is necessary to investigate cognitive styles and various types of instructional stimuli design so that a match between style and stimuli can be made rather than a "mismatch."

The cognitive styles of interest in the present study were field-dependents and field-independents. The primary researcher in the area of fd/fi has been Witkin. Witkin, et al.[*] (1977) point out the critical nature of research in the area of cognitive styles by noting:

> While research on educational applications is still in its early stages, the evidence that research has already produced suggests that a cognitive-style approach may be applied with profit to a variety of educational issues. It accordingly seems timely to bring to the attention of educators the concept of cognitive styles in general and the work of field-dependents-independents in particular . . . . (p. 1)

There is extensive evidence to indicate that the cognitive style of fd/fi manifests itself through the learners' thinking, problem solving and symbolic representations of his or her experiences in the learning situation. While the cognitive styles of fd/fi influence social, as well as intellectual perceptions of environmental stimuli, the present investigation will concentrate on only intellectual characteristics. In general the field-independent cognitive style can be characterized as an analytic perceiver of stimulus information. The fi is able to perceive relevant items as discrete from their background. When perceiving a complex visual for example the fi can identify the important figure from the background information. During problem solving the fi can restructure the problem elements, which tends to facilitate finding the solution in many problem solving situations. The fi is able to impose a structure on chaotic visual stimuli. The fi is able to store information in highly discrete conceptual categories, in other words the fi tends to think in terms of mature or "full blown" concepts. The fd can be characterized as a global thinker. The fd will tend to confuse figure/ground relationships, being unable, or having difficulty separating the relevant item from the background. This situation is especially accute when perceiving a complex stimuli. Problems requiring a restructuring of the problem elements are especially difficult for the fd. For the fd a chaotic stimuli situation will remain chaotic, because the fd attempts to remember the entire "global" percept. The fd stores conceptual data in overlapping categories, rather than discrete conceptual categories.

---

[*] H.A. Witkin, C.A. Moore, D.R. Goodenough, and P.W. Cox.

The external variable of interest in this study was visual complexity. There were three levels of the visual complexity variable. The visual display levels constituted three slide programs making up the visual portion of an instructional segment on the human heart. The relevant academic information presented in each program was identical. The three levels of visual complexity varied only in the amount of irrelevant data contained in the visual display. Current research tends to indicate that a simplified visual presentation of information is generally processed more effectively by learners (Dwyer, 1967; Travers, 1970).

The first level of the visual complexity variable consisted of line drawings of the heart and its appropriate parts. The majority of the focal information in this visual was relevant information. The second level of the visual complexity variable consisted of a detailed color illustration of the heart and its parts. In this visual design relevant focal information and irrelevant focal information were approximately equal in amount. The third level of the visual complexity variable consisted of realistic photographs of a disected heart. This visual contained more irrelevant focal information than relevant focal information.

The final area of interest in this study was level of objective or learning outcome. Three dependent measures were used to attain data on three types of learning outcomes. The first learning outcome was list learning. This was measured by the Identification Test (Dwyer, 1967). In this situation the learner had to acquire the names of the parts of the heart. The second learning outcome considered acquisition of information on the spatial/location of a part in the set of all parts of the heart. This learning outcome was measured by the Drawing Test (Dwyer, 1967). The third learning outcome was the acquisition of relational concept information about the interactions of the parts of the heart. This was measured by the Comprehension test (Dwyer, 1967).

Design and Method

The design of the study was a 2 x 3 analysis of variance. There were two levels of the cognitive style variable; field-independents and field-dependents. There were three levels of the visual complexity variable: (1) line drawing 2 x 2 slide set, (2) detailed illustration 2 x 2 slide set, (3) realistic photograph 2 x 2 slide set. Performance on acquiring information was measured using three dependent measures, each measuring a different level of difficulty in terms of learning outcome (e.g., list learning, spatial-location learning, and relational concept learning). Also of interest in the design were two attitudinal questions on preference for visual learning. This attitudinal measure data had four possible answers and was analyzed using a chi-square analysis.

Subjects consisted of 50 undergraduates from an instructional media course at Ohio State during fall term 1979. They were given the Thurston Closure test to determine their field-dependents-independents. Subjects were then randomly assigned to the visual stimulus treatments. They were presented the visual treatments in the form of a slide/tape instructional program about the heart. Immediately after the instructional program was over all subjects were given the three dependent measures. The attitudinal questions were presented prior to viewing the instructional program.

Results and Discussion

Four separate data analysis were completed for the measures. An unequal n's analysis was done on the Identification Test, Drawing Test and Comprehension Test. A chi-square was calculated on the attitudinal measure.

The Identification test measured the learner's ability to acquire the names of the parts of the heart. This was considered the simplist learning outcome since it required only the learning of a list of terms, no other information about the terms was acquired. Data analysis indicated significance on the complexity variable, [f, $(2,44) = 3.50$, $p < .04$]. Follow-up testing with a Tukey WSD at .05 alpha finds significance favoring the illustration ($\bar{X} = 16.12$) over the line drawing ($\bar{X} = 13.18$) and the photographic display (13.21). The analysis found no significance between the fd/fi variable, [f $(1, 44) = .76$, p. $< .39$].

Significance did not occur on the fd/fi variable because the list learning task was quite simple and could not deter the performance of the fd's. In other words most learners could easily acquire a list of information. In the context of this situation it is difficult to explain why the color illustration was significantly better for list learning than the line drawing or the photograph.

The Drawing Test measured the learner's ability to acquire spatial-location data from the instructional program. This learning outcome is more difficult than list learning. Analysis yielded significant results on the Drawing Test (f $(1, 44) = 9.51$, $p < .004$], favoring the field-independents ($\bar{X} = 12.7$) over the field-dependents ($\bar{X} = 8.13$). Significant results did not occur on the stimulus variable [f $(2, 44) = .53$, $p < .59$]. A significant interaction also failed to occur in this analysis [f, $(2, 44) = 1.99$, $p < .15$].

The fd's had more difficulty acquiring spatial-location data than the fi's. The acquisition of spatial information requires the restructuring of the stimulus situation since each part must be recalled in terms of its relation to the set of all possible parts. It is likely that the stimulus variable was non-significant because subjects had too much time to interact with each slide (15 to 20 seconds after the narration ended). The interaction approached significance and it is likely that an equal n's analysis would find a significant interaction between the fd/fi and stimulus complexity variables, demonstrating a difficulty for the fd's in acquiring data from complex visuals.

Analysis yielded significant results on the Comprehension Test [f, (1, 44) = 6.58, $p < .004$], favoring field-independents ($\bar{X} = 8.62$) over field-dependents ($\bar{X} = 6.5$). Significance did not occur on the stimulus variable [f, (2, 44) = 1.22, $p < .31$] or the interaction between variables [f, 2, 44) = .81, $p < .45$].

The Comprehension Test measured the acquisition of relational concept information about how the parts of the heart interact during the heart's operation. This was a more difficult type of learning than list or spatial learning. The acquisition of relational concepts requires the use of analytical thinking, which fi's could carry out. Unfortunately the global thinking fd's were left at a disadvantage for this type of learning. The stimulus variable had no effects upon learning because too much time was given for interaction with each visual stimulus.

The attitudinal measure yielded a significant chi-square value of 44.22, indicating significance at $p < .001$. This result is interpreted to mean that learners preferred to learn from visuals and felt that they recall visual information more effectively than print information.

The present study indicates learning differences between fd's and fi's for different learning outcomes. This particular study is preliminary in nature and does not offer specific conclusions for the design of effective visuals for fd's and fi's for perceptual learning. Future studies in this area should control for the interaction time the learner has with each visual. In fact this could be another variable for research. The construct of cognitive styles must be investigated in terms of specific media and specific learning outcomes.

References

Bieri, J., "Complexity-Simplicity as a Personality Variable and Preferential Behavior." In D.W. Fiske and S.R. Maddi, Functions of Varied Experience. Homewood, Ill., Dorsey Press, 1961.

Cross, P.K., Accent on Learning, Jossey-Bass, S.F., Calif., 1976.

Dwyer, F.M., Jr., A Study of the Relative Effectiveness of Varied Visual Illustrations, U.S., HEW, Project 6-884-, of Grant OEG-107-068840-0290, 1967.

Dwyer, F.M., Strategies for Improving Visual Learning, State College, Pa., Learning Services, 1978.

Harvey, O.J., Hunt, D.E. and Schroder, H.M., Conceptual Systems and Personality Organization, N.Y., Wiley, 1961.

Kelly, G.A. The Psychology of Personal Constructs., Vol. 1., N.Y., Norton, 1955.

Miller, G.A., Galanter, E. and Pribram, K.H., Plans and the Structure of Behavior, Holt, Rinehart, and Winston, N.Y., 1960.

Travers, R.M.W., Man's Information System, Chandler Publishing Co., Scranton, Pa., 1970.

Witkin, H.A., Moore, C.A., Goodenough, D.R., Cox, D.W., Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications, Rev. Ed. Res., 1977, Vol. 47, No. 1, pp. 1-64.

TITLE: Imagery-A Return to Empirical Investigation

AUTHORS: Judy N. Chiswell

Richard Lamberski

IMAGERY -
A RETURN TO EMPIRICAL INVESTIGATION

Judy N. Chiswell
Director - Instructional Resource Center
Assistant Professor - Sargent College of Allied Health Professions
Boston University

and

Richard J. Lamberski
Director - University Media Services
Assistant Professor - Division of Instructional Development
Boston University

Research & Theory Division
Association for Educational Communications & Technology
Denver, Colorado
Thursday - April 24,1980

ABSTRACT

Purpose

The purpose of this paper is to provide a review of the current return to empirical investigation of the mind's component known as imagery. Specifically the paper will focus on:

1. The historical perspective of imagery investigations;
2. The multiple terms defining various states of imagery;
3. The examination of imagery in the behavioral sciences;
4. The examination of imagery in the biological sciences;
5. Interdisciplinary studies in the functioning of the brain;
6. The development and current use of instrumentation isolating imagery elements; and
7. Discussion of periodicals and organizations promoting the study of imagery.

Perspective

Current interest in the investigation of imagery has emerged after years of isolation in the sciences; the banishment historically occured during the beginning of the behaviorists movement in psychology. Imagery, attention, states of consciousness and other such central themes of the old era were labeled as "mentalistic" and therefore eliminated from scientific investigation. The resurgence in imagery investigations has brought about confusion to the reader due to the lack of appropriate conceptual and operational definitions of the whole spectrum of types of imagery.

Further Emphasis

While the authors recognize the vast related literature and issues encompassing imagery, the intent of the paper is to provide a primer for the serious consideration by researchers of this multi-dimensional topic. In providing this information, we wish to call attention to the need to consider the internal functioning of the mind which addresses issues which can not be thoroughly interpreted through perceptual investigations of the external reception by the brain.

The concluding discussion will highlight current organizations, special interest groups, journals and books that focus on the study of imagery.

Imagery: A Return To Empirical Investigation

Purpose

The purpose of this paper is to provide a review of the current return to empirical investigation of the mind's component known as imagery. Specifically the paper will focus on:

1. The historical perspective of imagery investigations;
2. The multiple terms defining various states of imagery;
3. The examination of imagery in the behavioral sciences;
4. The examination of imagery in the biological sciences;
5. Interdisciplinary studies in the functioning of the brain;
6. The development and current use of instrumentation isolating imagery elements; and
7. Discussion of periodicals and organizations promoting the study of imagery.

While the authors recognize the vast related literature and issues encompassing imagery, the intent of the paper is to provide a primer for the serious consideration by researchers of this multi-dimensional topic. In providing this information, we wish to call attention to the need to consider the internal functioning of the mind which addresses issues which can not be thoroughly interpreted through perceptual investigations of the external reception by the brain.

Historical Perspective

Imagery was introspectively analyzed during the psychology of the 1890's; that is, imagery was a prominent part of the science of mind, its contents and laws. The early clinical literature revealed psychology's interest in hallucinations and other types of images up until the early 1900's. But despite the emergence of eidetic imagery as a topic of investigation through the 1930's, psychologists lost interest in imagery. For over 50 years the interest in imagery had been in disrepute in the psychology field. States of consciousness, attention, and imagery were labeled 'mentalistic' in the years just before World War I when the new approaches to psychology (behaviorism and psychoanalysis) began to emerge. Watson (1913) warned that introspective studies were not scientific enough and were much too subjective to verify or replicate. The S-R psychologists assumed that the central nervous system functioned as a connective device similar to a telephone switchboard. Stimuli evoked responses via central connections. The central mechanisms had no other role to play. Unfortunately in Watson's day most "psychologists had not heard of brain waves, spontaneous neural discharges, or of the reticular activating system" (Bugelski, 1971, p.50).

The renewal of interest in imagery as a legitimate area for scientific study has been noted by many authors (Bower, 1972; Holt, 1964; Paivio, 1971; Richardson, 1969; Segal, 1971). Hebb (1960) has recognized that "these notions of thought, imagery, relate to a vital problem in the understanding of man" (p.736). Several factors have contributed to the re-emergence of imagery studies. Verbal learning research provided one context for change. "The revolution in verbal learning brought about the rejection of the nonsense syllable and the substitution of ordinary words, sometimes in sentences or paragraphs, and a new concern over what the learner had to contribute to the learning and/or retrieval process" (Bugelski, 1977, p.40).

Defining Imagery

Since 1960 psychologists have attempted to categorize and define mental imagery. Several types of imagery will be distinguished as described in detail by Samuels and Samuels (1975).

Memory is the most common kind of visualization. The memory image has been referred to as the mental picture or seeing with the mind's eye. Some people feel that they do not "see" the image, but that they have a strong sense of the image and "know" what it looks like. A more formal definition of the memory image is a "a reconstruction or resurrection of a past perception" (Horowitz, 1970, p.22). A memory image may be summoned or maybe experienced spontaneously. Psychologists use two concepts in describing memory images: vividness and controlability. Indeed memory images may range in vividness, from vague and fuzzy to clear and detailed.

Eidetic imagery is an especially vivid form of memory image. The phenomenon has even been referred to as photographic memory. Child development researchers have found that eidetic images are most frequently experienced by young children. This activity seems to diminish in adolescence when abstract thought and higher level verbal skills develop.

Imagination is another common visualization experience. Elements of the past rearranged in a different way than originally perceived will be contained in the imagination image. Often, the imagination image will be a source of solutions to problems, a basis of new work for the creative person.

Daydreams and fantasy combine memory and imagination images. In daydreams a series of images more or less in chronological order take place. The images seem to be part of an internal continuum. The daydream experience is more similar to events in external reality than memory images, and a person is less likely to appreciate the experience as a visualization.

Hypnagogic and hypnopompic imagery experiences occur in the twilight state between states of sleep and waking. When occuring before sleep they are called hypnagogic; when they occur just after sleep, before becoming fully awake, they are called hypnopompic. These images generally tend to be vivid, detailed and beyond the reach of conscious control.

Dreams are considered one of the most important categories of imagery. Sleep studies have shown that people dream throughout sleep, but are most likely to report visual images during phases of REM sleep. Dreams can have the most compelling sense of reality of all the types of imagery.

Hallucination or vision is less frequently experienced as visualization. Usually the person believes the image he saw was external to himself. Research has shown that these images are extremely vivid and can occur when people are under the influence of certain drugs, praying or meditating, deprived of sleep or food, been in sensory deprivation chambers, experience high fever, or experienced repetitive situations such as night driving.

After-image and the recurrent image are two other common types of visual experience. The after-image takes place after looking at a bright object against a dark background. The original image lasts a few seconds then it is followed by a negative after-image. The recurrent image occurs if prolonged periods are spent staring at the same scene. The image may occur immediately after looking at the scene or several hours later when eyes are closed to rest.

Psychologists have found these definitions and labels of imagery useful for researching visualization. However, it is apparent that all of these visual images share a common continuum in defining the nature of the mental image. Additional definitions can be found in Holt (1964), Segal(1971), or Sheehan(1972).

Imagery in the Behavioral Sciences

The empirical investigation of imagery as a mediator of behavior in the acquisition, storage and retrieval of information has been approached in several ways. For example words have been rated along an imagery dimension in terms of the ease with which they evoke a sensory image; or, imagery has been operationally defined as instructions to use imaginal processes in performing certain tasks. Another approach has been to investigate individual differences in the ability to elicit and utilize images in thinking and problem solving. Several of these approaches will be presented in more detail.

In one approach to imagery, when pictures are compared to words as stimuli in experimental learning tasks, significant differences are usually found (Paivio, 1969; Paivio & Rowe, 1970; Paivio & Smythe, 1971). Imagery in these studies are defined in terms of image-arousing value or concreteness of the stimulus materials. Paivio (1969) has suggested that words can derive their meaning through at least two kinds of associations. Concrete words presumably derive their meaning through associations with concrete objects and events as well as through associations with other words. Therefore, such words acquire the capacity to evoke both nonverbal images and verbal processes as associative reactions. Abstract words, however, derive their meaning primarily through intraverbal experiences and more effectively arouse verbal associative than imaginal processes. When imagery evoking words have been used in word pair experiments, the noun-adjective order as opposed to the adjective-noun order have been more easily learned (Lambert & Paivio, 1956; Paivio, 1963; Yuille, Paivio, & Lambert, 1969). Imagery evoking words have also been found to be positively effective in free recall, serial learning and verbal discrimination learning. Clear exceptions to this positive effect occur when sequential memory tasks are demanded, where words rather than pictures result in a better performance (Paivio & Caspo, 1969). The difficulty of identifying the type of imagery used in these paired-associate tasks has been studied by Calvano (1974). Calvano could find no significant predictors of performance using seven different cognitive factor tests because of the inability of the tests to identify the actual type of imagery necessary to make associations.

In another approach to imagery, instructions or training on the use of imagery have been manipulated in the various studies (Bower, 1972; Bugelski, Kidd, & Segman, 1968; Paivio & Yuille, 1967, 1969). Generally, the findings from these experiments consistently show a positive effect in the ability to recall information when imagery is used as a mediational device.

Other researchers have attempted to identify imagery at various developmental stages. For example Pressley (1977) focuses attention on the effects of imagery at various developmental levels but in particular in children's learning. Findings indicate that children's learning from imposed pictures are almost always learned better than words. From ages 4 to 10 children's pictorial recognition is superior to verbal recognition. Furthermore it was found that imposed images can increase children's prose learning if the pictures accurately depict information from the text. To the extent that pictures depict inaccurate or irrelevant information, pictures were found to have an adverse effect on children's prose learning.

The approach which has generated the most conflicting speculations of internal mechanisms stems from the research investigating the memory structures by which pictures and words are processed. One view is referred to as the verbal loop hypothesis (Glazer & Clark, 1963). This single system hypothesis of picture-word memory proposes that people process pictures by translating picture information into a series of words, storing this verbalization, and retrieving from it if a response is required. An opposing view by Paivio (1971, 1974) proposes a dual coding hypothesis in which two separate memory systems (one for verbal symbolic processes and another for nonverbal imagery processes)are utilized. He states that the two systems may operate independently, but are interconnected and may also operate in conjunction with each other. Reasearchers currently feel that continued investigations in mental imagery will provide possible explanations to these proposed memory and processing structures. The importance of this line of research has recently been stated by Fleming (1977) who contends that a better understanding of how humans process, store, and regenerate pictorial information will be beneficial to both media research and practice.

8

Imagery in the Biological Sciences

Exciting explorations in the neurosciences and medicine have been extending our understanding of the nature of the mental image and its importance in our daily lives. The mental image, in particular the visual image is currently incorporated in the treatment of cancer patients (Simonton & Matthews-Simonton, 1978), psychosomatic patients with migraine headaches, Raynaud's disease, hypertension and asthma (Green & Green, 1977) and chronic pain patients (Shealey, 1977). Through relaxation and visualization patients are directed to imagine the location of their diseases in their bodies, "see" the natural immune agents of the body engage with the treatment to fight the disesase, and then visualize the body ridding itself of the unwanted cells through its normal elimination system.

Coué and Brooks (1974), strong proponents of the power of the imagination over the will, encouraged all of their patients to allow their bodies to respond to their imaginations for healing. The basic premise being that the person make a clear mental statement of what he or she wants to happen. Thus, the person visualizes the desired outcome and in this way mental imagery serves as a method for self-direction.

In other biological approaches scientists, exploring the use of biofeedback, have realized that the mental image can serve as the link between the conscious and autonomic functions of the body (Green & Green, 1977). As patients respond to the lights, dials or tones of the biofeedback equipment the conscious mind forms links to the subconscious through kinesthetic sensation and visual images. When patients are "trained" the equipment is no longer needed because the patient maintains a mental image of the sensation and visualizes the alterations of the autonomic system through changes in temperature, circulation, heart rate or blood pressure. Other approaches have included studies: in hallucinations and the effects of hallucinogenic drugs (Horowitz, 1964; Saravay & Pardes, 1967); in sensory and perceptual deprivation (Bexton, Heron & Scott, 1954; Shurley, 1962; Ziskind, 1965); in the effects of marginal and subliminal stimuli (Fisher & Paul, 1959; Pötzl, 1917; Shevrin & Luborsky, 1958); in neurology such as electroencephalography, direct stimulation of the brain, and the reticular activating system of the brain stem (Penfield, 1951; Scheibel & Scheibel, 1962); in hypnosis and auto-suggestion (Fromm & Shor, 1972; Kroger, 1963; LeCron, 1971; Luthe & Schultz, 1969); and in biofeedback and creativity (Arieti, 1976; Green & Green, 1977).

Functioning of the Brain

Recently interdisciplinary studies in neurophysiological research has provided behavorial and cognitive researchers with new insights into memory and processing structures. The evidence from neurophysiological research lends support to the plausibility of two independent memory systems. The distinction between the processing of verbal and nonverbal stimuli have been made in connection with the apparent functional asymmetries of man's two cerebral hemispheres (Kimura, 1973).

Research has indicated that left and right hemispheres in man are to some extent specialized for different perceptual and cognitive processes. Evidence from unilateral cerebral lesions (Milner, 1971; Rubino, 1970) and observation of the abilities of the separate hemispheres following forebrain commisurotomy (Gazzaniga & Sperry, 1967) have shown that in most right handers, the left hemisphere is commonly involved in verbal numerical tasks while the right is specialized in complex spatial processing.

A number of recent studies have reported hemispheric asymmetry in the electroencephalograph (EEG) as a function of cognitive tasks (Galin & Ornstein, 1972; Goodman, Beatty, & Mulholland, 1980 ; Morgan, MacDonald, & Hilgard, 1974; Morgan, McDonald & MacDonald, 1971; Rebert & Mahoney, 1978). The investigations indicate that verbal tasks are typically associated with increases in high frequency left hemisphere activity (or a corresponding decrease in alpha activity) relative to right hemisphere activity; while spatial tasks are associated with the opposite asymmetry.

Other current research has suggested that the brains of male and female humans are differentially lateralized with respect to cognitive function (Bouchard & McGee, 1977; Buffrey & Gray, 1972; Eisenburg & McGinty, 1977; Marshall, 1973; Witelson, 1976). Evidence has also been generated which indicates that cerebral lateralization develops sooner in females than in males (Kimura, 1967). Whether this early hemispheric specialization among females continues into adulthood does not seem conclusive as yet. Tucker (1976) supports the theory that there is less differential usage of the hemispheres in females than in males who tend to show greater hemispheric specialization. Systematic studies to assess differences in cerebral asymmetry between the sexes during performance of a variety of cognitive tasks will aid in exploring this theory. Use of the EEG may help to objectify these investigations.

Instrumentation Isolating Imagery

Of primary interest to researchers has been the attempted developments of written tests which can accurately assess one or several elements of imagery. Researchers investigating imagery as an individual difference variable have developed two types of rating scales to identify high or low imagery ability. The first type of assessment involves a subjective scale of "vividness" which can be defined as the quality of the image (vivid or vague) that the person is able to envision in their mind (Marks, 1972; Sheehan, 1966; Sheehan & Neisser, 1969). The second type of assessment involves the use of spatial manipulation tests (Ernest & Paivio, 1969; Paivio, 1971; Stewart, 1965). We will discuss instruments which are respective of both scales.

Historically, Galton (1880) developed the first imagery questionnaire. He made the first observations on imagery, related them to differences in sex and age, and raised the possibilty of training individuals to increase the vividness of their evoked images.

The test that became most frequently administered was the Betts' (1909) Questionnaire upon Mental Imagery. Unlike Galton's test, which emphasized visual images, Betts' test with 150 items evaluated vividness of evoked imagery in seven sensory modalities: visual, auditory, cutaneous, kinesthetic, gustatory, olfactory, and organic. In the 1960's Sheehan (1967) constructed a shorter version of the Betts' test with only 35 items which he called the Betts QMI.

Recently Marks (1973) published an imagery questionnaire which concentrated exclusively on the visual modality. His test, called the Vividness of Visual Imagery Questionnaire (VVIQ), contains 16 items; the five visual items from the Betts QMI are supplemented by the addition of 11 new items.

Several authors have surveyed the psychometric properties of these self-report inventories of imagery (White, Sheehan, & Ashton, 1977). Their findings seem to indicate that these inventories show a degree of reliability in terms of internal consistency and test-retest stability. However, establishing their validity as measuring instruments seems to be a problem because the items on the scales may not mean the same thing to every subject. The second type of instruments involve the space factor. The space factor, found by Thurstone (1938), was defined as facility with spatial and visual imagery. The space factor was measured by tests such as Flags (Thurston & Jeffrey, 1956) in which the items are pairs of flags with the two members shown in different positions and the subject is to indicate whether or not one has been turned over to show the reverse side.

Among the many tests of this kind, those that have been used in research on imagery include the Flags Test, the Minnesota Paper Form Board, the Kuhlmann-Finch Space Test, and Thurstone's Spatial Relations Test. The spatial ability tests are perceptual in nature and are usually grouped or correlated with cognitive abilities. For example Guilford (1967) interprets images as revivals of the perceptual experience and places them in the categories of memory abilities. While Paivio (1971) adopts a more general viewpoint and considers imagery as appropriately falling into both cognition and memory categories. The administration of these instruments have enabled researches to identify several individual differences which relate to cognitive processes and memory. Studies have shown that individuals identified as high in imagery ability, according to objective spatial test, surpass low imagers in their incidental memory for visual stimuli (Sheehan & Neisser,1969), in the speed of their imaginal and verbal associative reactions to concrete and abstract stimulus words (Ernest & Paivio, 1971a), and in the accuracy with which they identify stimuli (Ernest & Paivio, 1979b).

Di Vesta and Ross (1971) have found that high imagers have an advantage over low imagers when the stimulus is of low rated imagery. On the other hand, there is less difference in performance between the two groups when the stimulus is of high rated imagery. From the Di Vesta and Ross study (1971) it appears that imagery ability affects performance for the same reasons that concrete stimuli do. When stimuli are concrete there is no further advantage to be gained by having high imagery ability; the stimuli are equally discriminable to both high and low imagers. However, when stimuli are of low rated imagery, that is, when they are abstract, their ambiguity can be lessened by the imaginal ability of the high imager. Additional support for this theory may be found in Ernest and Paivio (1971a). When they measured reaction times to elicit a verbal associate or to arouse an image, the high imager's performance was superior to that of the low imager when the stimuli was abstract.

Summary

The primary issue which the authors have attempted to address in this paper is that the recent developments and techniques in imagery research offer new evidence and insights into plausible theories of the mind's functions. The re-emergence of imagery as a research area has been prompted by the expanded technology and improved instrumentation.

We have provided the terminology necessary to identify the possible areas of imagery exploration. The current studies selected and presented from the behavioral sciences and biological sciences have both immediate applicability and further potential. The findings of these studies validate theories of cognition and physiological processing while offering controversy and need for further interrelatedness by other investigators.

In conclusion the authors wish to reinforce their initial statement that the field of educational communications and technology has available a growing literature base which complements the external visualization and perception research. This "imagery" literature and increasing resources provides the foundation for further investigations into the internal visualizing and processing of the mind's functions.

Periodicals and Organizations

National and international interest in the study of mental imagery has resulted in a variety of new periodicals and organizations. Source information for contacting these organizations and publishers follows the reference list.

Of special note is the Journal of Mental Imagery which began publishing a selection of experimental, clinical, theoretical, and review articles on mental imagery in the Spring of 1977. Also the Brain Mind Bulletin is published every first and third Monday. It provides a brief review of new theories and techniques, practical applications, research ideas and news of conferences. A bulletin entitled Imagery is published by a new organization, the American Association for the Study of Mental Imagery.

Lastly the American Educational Research Association has recently formed a new Special Interest Group: Mind/Body Education. Their purpose is to undertake and promote research into the areas of biofeedback, left/right

Hemisphere studies, state-specific studies (e.g., dreams, several kinds of meditation, yoga, hypnosis, auto-suggestion, imagery, and mind drugs) and latent abilities to determine their educational significance and implications.

REFERENCES

Arieti, S. Creativity, the magic synthesis. New York: Basic Books, 1976.

Betts, G.H. The distribution and functions of mental imagery. New York: Teachers College, Columbia University, 1909.

Bexton, W.H., Heron, W., & Scott, T.H. Effects of decreased variation in the sensory environment. Canadian Journal of Psychology, 1954, 8, 70-76.

Bouchard, Jr., T.J., & McGee, M.G. Sex differences in human spatial ability: not an X-linked recessive gene effect. Social Biology, 1977, 24(4), 332-335.

Bower, G.H. Mental imagery and associative learning. In Lee Gregg (Ed.), Cognition and learning memory. New York: Wiley, 1972.

Buffery, A.W.H., & Gray, J.A. Sex differences in the development of spatial and linguistic skills. In C. Ounsted & D.C. Taylor (Eds.), Gender differences: their ontogeny and significance. London: Churchill Livingstone, 1972.

Bugelski, B.R. The definition of the image. In S.J. Segal (Ed.), Imagery: Current cognitive approaches. New York: Academic Press, 1971.

Bugelski, B.R., Kidd, E., & Segman, J. Image as a mediator in one-trial paired-associate learning. Journal of Experimental Psychology, 1968, 76, 69-73.

Calvano, M.A. Predicting the use of imagery as a mediation strategy. AV Communication Review, 1974, 22(3), 269-277.

Coué, E., & Brooks, C.H. Suggestion and auto-suggestion. New York: Samuel Weister, 1974.

Di Vesta, F.J., & Ross, S.M. Imagery ability, abstractness and word order on variables in recall of adjectives and nouns. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 686-693.

Eisenberg, T.A., & McGinty, R.L. On spatial visualization in college students. The Journal of Psychology, 1977, 95, 99-104.

Ernest, C.H., & Paivio, A. Imagery ability in paired-associate and incidental learning. Psychonomic Science, 1969, 15, 181-182.

Ernest, C.H., & Paivio, A. Imagery and verbal associative latencies as a function of imagery ability. Canadian Journal of Psychology, 1971a, 25, 83-90.

Ernest, C.H., & Paivio, A. Imagery and sex differences in incidental recall. British Journal of Psychology, 1971b, 62, 67-72.

Fisher, C, & Paul, I.H. The effect of subliminal visual stimulation on imagery and dreams: a validation study. Journal of American Psychoanalytic Association, 1959, 7, 35-83.

Fleming, M.L. The picture in your mind. AV Communication Review, 1977, 25(1), 43-62.

Fromm, E., & Shor, R.E. Hypnosis: Research developments and perspectives. Chicago: Aldine-Atherton, Inc., 1972.

Galin, D., & Ornstein, R. Lateral specialization of cognitive mode: an EEG study. Psychophysiology, 1972, 9(4), 412-418.

Galton, F. Statistics of mental imagery. Mind, 1880, 5, 301-318.

Gazzaniga, M., & Sperry, R. Language after section of the cerebral commissures. Brain, 1967, 90, 131-148.

Glazer, M., & Clark, W.H. The verbal loop hypothesis: binary numbers. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 301-309.

Goodman, D., Beatty, J., & Mulholland, T.B. Detection of cerebral lateralization of function using EEG alpha-contingent visual stimulation. Electroencephalography and Clinical Neurophysiology, 1980, 48, 418-431.

Green, E., & Green, A. Beyond biofeedback. San Francisco: Delacorte Press/Seymour Lawrence, 1977.

Guilford, J.P. The nature of human intelligence. New York: McGraw-Hill, 1967.

Hebb, D.O. The American revolution. American Psychology, 1960, 15, 735-745.

Holt, R.R. Imagery: the return of the ostracized. American Psychologist, 1964, 19, 254-264.

Horowitz, M. The imagery of visual hallucinations. Journal of Nervous and Mental Diseases, 1964, 138, 513-523.

Horowitz, M. Image formation and cognition. New York: Appleton-Century-Crofts, 1970.

Kimura, D. Functional asymmetry of the brain in dichotic listening. Cortex, 1967, 3, 163-178.

Kimura, D. The asymmetry of the human brain. Scientific American, 1973, 228, 70-78.

Kroger, W.S. Clinical and experimental hypnosis: in medicine, dentistry, and psychology. Philadelphia, PA: J.B. Lippincott, 1963.

Lambert, W.E., & Paivio, A. The influence of noun-adjective order on learning. Canadian Journal of Psychology, 1956, 10, 9-12.

LeCron, L.M. Self-hypnotism: the technique and its use in daily living. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1971.

Luthe, W., & Schultz, J. Autogenic therapy (6 vol.). New York: Grune and Stratton, 1969.

Marks, D.F. Individual differences in the vividness of visual imagery and their effect on function. In P. Sheehan (Ed.), The function and nature of imagery. New York: Academic Press, 1972.

Marks, D.F. Visual imagery differences in the recall of pictures. British Journal of Psychology, 1973, 64, 17-24.

Marshall, J.C. Some problems and paradoxes associated with recent accounts of hemispheric specialization. Neuropsychologia, 1973, 11, 463-470.

Milner, B. Interhemispheric differences in the localization of psychological processes in man. British Medical Bulletin, 1971, 27, 272-277.

Morgan, A.H., MacDonald, H., & Hilgard, E.R. EEG alpha: lateral asymmetry related to task and hypnotizability. Psychophysiology, 1974, 11(3), 275-282.

Morgan, A.H., McDonald, P., & MacDonald, H. Differences in bilateral alpha activity as a function of experimental task with a note on lateral eye movements and hypnotizability. Neuropsychologia, 1971, 9, 459-469.

Paivio, A. Learning of adjective-noun paired-associates as a function of adjective-noun word order and noun abstractness. Canadian Journal of Psychology, 1963, 17, 370-379.

Paivio, A. Mental imagery in associative learning and memory. Psychological Review, 1969, 76, 241-263.

Paivio, A. Imagery and verbal processes. New York: Holt, 1971.

Paivio, A. Language and knowledge of the world. Educational Researcher, 1974, 3(9), 5-12.

Paivio, A., & Csapo, K. Concrete image and verbal memory codes. Journal of Experimental Psychology, 1969, 80(2), 279-285.

Paivio, A., & Rowe, E.J. Noun imagery, frequency, and meaningfulness in verbal discrimination. Journal of Experimental Psychology, 1970, 85, 264-269.

Paivio, A., & Smythe, P.C. Word imagery, frequency, and meaningfulness in short-term memory. Psychonomic Science, 1971, 22, 333-335.

Paivio, A., & Yuille, J.C. Mediation instructions and word attributes in paired-associate learning. Psychonomic Science, 1967, 8, 65-66.

Paivio, A., & Yuille, J.C. Changes in associative strategies and paired-associate learning over trials as a function of word imagery and type of learning set. Journal of Experimental Psychology, 1969, 79, 458-463.

Penfield, W. Memory mechanisms. Transactions of the American Neurological Association, 1951, 76, 15-31.

Pötzl, O. The relationship between experimentally induced dream images and indirect vision. (Wolff, J., Rapaport, D., & Annin, S. Psychological Issues, 2 (whole no. 3), Monograph 7, 41-120 trans.) 1960. (Originally published in Z. Neurol. Psychiat. 37, 278-349).

Pressley, M. Imagery and children's learning: putting the picture in the developmental perspective. Review of Educational Research, 1977, 47(4), 585-622.

Robert, C.S., & Mahoney, R.A. Functional cerebral asymmetry and performance III. reaction time as a function of task, hand, sex, and EEG asymmetry. Psychophysiology, 1978, 15(1), 9-15.

Richardson, A. Mental imagery. New York: Springer Publishing Co., Inc., 1969.

Rubino, C.A. Hemispheric lateralization of visual perception. Cortex, 1970, 6, 102-120.

Samuels, M., & Samuels, N. Seeing with the mind's eye. New York: Random House, 1975.

Saravay, S., & Pardes, H. Auditory elementary hallucinations in alcohol withdrawal psychosis. Archives of General Psychiatry, 1967, 16, 652-658.

Scheibel, M.E., & Scheibel, A.B. Hallucinations and the brain stem reticular core. In L.J. West (Ed.), Hallucinations. New York: Grune and Stratton, 1962.

Segal, S. Processing of the stimulus in imagery and perception. In S. Segal (Ed.), Imagery: current cognitive approaches. New York: Academic Press, 1971.

Sheehan, P.W. Functional similarity of imaging to perceiving: individual differences in vividness of imagery. Perceptual and Motor Skills, 1966, 23, 1011-1033.

Sheehan, P.W. A shortened form of Betts' questionnaire upon mental imagery. Journal of Clinical Psychology, 1967, 23, 386-389.

Sheehan, P.W. The function and nature of imagery. New York: Academic Press, 1972.

Sheehan, P.W., & Neisser, U. Some variables affecting the vividness of imagery in recall. British Journal of Psychology, 1969, 60, 71-80.

Shevrin, H., & Luborsky, L. The measurement of preconscious perception in dreams and images: an investigation of the Poetzl phenomenon. Journal of Abnormal and Social Psychology, 1958, 56, 285-294.

Shurley, J.T. Mental imagery in profound sensory isolation. In L.J. West (Ed.), Hallucinations. New York: Grune and Stratton, 1962.

Simonton, O.C., & Matthews-Simonton, S. Getting well again. Los Angeles: J.P. Tarcher, Inc., 1978.

Stewart, J.C. An experimental investigation of imagery. Unpublished doctoral dissertation, University of Toronto, 1965.

Thurstone, L.L. Primary mental abilities. Psychometrika, 1938, No.1, (Monograph).

Thurstone, L.L., & Jeffrey, T.E. Flags: a test of space thinking. Chicago: Education Industry Service, 1956.

Tucker, D.M. Sex differences in hemispheric specialization for synthetic visuospatial functions. Neuropsychologia, 1976, 14, 447-454.

Watson, J.B. Psychology as the behaviorist views it. Psychological Review, 1913, 20, 158-177.

White, K., Sheehan, P.W., & Ashton, R. Imagery assessment: a survey of self-report measures. Journal of Mental Imagery, 1977, 1(1), 145-170.

Witelson, S.F. Sex and the single hemisphere: specialization of the right hemisphere for spatial processing. Science, 1976, 193, 425-427.

Yuille, J.C., Paivio, A., & Lambert, W.E. Noun and adjective imagery and order in paired-associate learning by French and English subjects. Canadian Journal of Psychology, 1969, 23, 459-466.

Ziskind, E. An explanation of mental symptoms found in acute sensory deprivation: researches 1958-1963. American Journal of Psychiatry, 1965, 121, 939-946.

PUBLICATIONS EMPHASIZING IMAGERY

Brain Mind Bulletin
Interface Press
P.O. Box 42211
Los Angeles, CA 90042

Imagery: Bulletin
American Association for the Study of Mental Imagery
580 S. San Vincente Blvd.
Los Angeles, CA 90048

Journal of Mental Imagery
Brandon House, Inc.
P.O. Box 240
Bronx, New York 10471

PROFESSIONAL GROUPS EMPHASIZING IMAGERY

The American Association for the Study of Mental Imagery
580 S. San Vincente Blvd.
Los Angeles, CA 90048 (213) 658-8497

Special Interest Group: Mind/Body Education
American Educational Research Association
1230 17th Street, N.W.
Washington, D.C. 20036
Current Chairperson: Gary F. Render
College of Education
University of Wyoming
Laramie, Wyoming 82071

TITLE: A Meta-Analytic Study of Pictorial Stimulus Complexity

AUTHORS: Francis E. Clark

Jay F. Angert

title • A Meta-Analytic Study of Pictorial Stimulus Complexity

presenters • Francis E. Clark, Director
Educational Technology
College of Education
Texas A&M University
College Station, TX 77843

• Jay F. Angert
Educational Technology
College of Education
Texas A&M University
College Station, TX 77843

A META-ANALYTIC STUDY OF PICTORIAL STIMULUS COMPLEXITY

As an applied field of communication, educational technology has concerned itself with the practical utilization of communications technology in the instructional process. This focus has created a large body of media research studies with discouraging appraisals of the value of these media research efforts (Bracht, 1970; Cronbach & Snow, 1977; Dwyer, 1978; Fleming, 1970; Hawkridge, 1973; Heidt, 1977; Parkhurst, 1975). It has been suggested, as one solution to these difficulties, that the pertinent variables in media research be reconceptualized.

In 1965, Lumsdaine and May stated that educational media research was a field frequently defined in terms of presentation modes rather than on a more fundamental basis. Both Conway (1967) and Knowlton (1964) observed that media researchers have made no consistent distinction between the sensory modalities involved in communication and the coding systems incorporated in the message. Knowlton noted the regrettable mix of pictorial and verbal elements in audiovisual presentations and the lack of a carefully described unit of analysis, specifically the pictorial iconic sign. This description, he continued, was essential to the development of a science of audiovisual communication. In 1966, Norberg lamented that considerable audiovisual research dealt only with media presentations; iconic signs had rarely been an experimental variable. In 1978, Levie clearly specified that one area of media research emphasis should be the symbolic codes of pictorial media. Levie was referring to the iconic coding system which uses referent symbols (e.g., pictures) to communicate, as opposed to the digital coding system (e.g., words and numbers) which communicates by non-referent symbols (Littlejohn, 1978; Schramm, 1977).

Salomon (1974) argued that media need not be represented only in terms of presentation techniques or technology systems (e.g., television, computer-assisted instruction), but could also be represented as consisting of messages (subject-matter content) or symbolic systems. This last method of representation has received the least emphasis. In delineating the potential elements in a taxonomy of media attributes, Salomon described a tentative hierarchy of symbol systems (e.g., digital, iconic), coding elements (e.g., dimensionality, iconicity), secondary coding systems (e.g., editing, sequencing), and such additional features as complexity, redundancy, or ambiguity. In a review of Salomon's analysis, Schramm (1977) acknowledged the desirability of such a taxonomy, regretted that it was not close at hand, and admitted that media researchers have "only the foggiest of ideas about the area that Salomon is opening up" (p. 87).

Many of the conceptual difficulties in media research may be related to a decreasing link, described by Hill (1978), between communication theory and instructional media research. Mielke (1972) also has noted that "the current trends and emphases in instructional media research . . . have involved increased association with educational psychology and decreased association with general communication theory and research" (p. 358). Similarly, Allen (1971) concluded that the "broad field of communication research never became integrated with the mainstream of instructional media research, and to this day these related disciplines are taking different routes" (pp. 6-7).

Dance (1970) observed that the diverse fields involved in the study of communication have created considerable looseness in the definition of the concept of communication. Westley and MacLean (1974) found this looseness counter productive, noting that there exists a "jungle of unrelated concepts and systems of concepts . . . and a mass of undigested . . . sterile empirical data" (p. 336). Consequently, Mortensen (1972) considered the prospects unlikely for a synthesized communication theory. Despite this deficiency, many communication models possess certain essential commonalities which can be directly related to instructional media research. Deutschmann, Barrow, and McMillan (1961) considered the Shannon-Weaver (1949) model as directly applicable to the classroom. Berlo (1960), moreover, observed that a comparison of the process models generally indicated a great deal of similarity.

One basic area of agreement among the various descriptive and graphic models of the communication process lies in the recognition of the importance of codification and sign usage. Littlejohn (1978), for example, described coding as a fundamental concern in the study of communication and concluded that "essentially every theoretical approach to communication takes place through the use of signs" (p. 80). Salomon (1974) stated that one of the key steps in designing instructional media is the selection of a symbolic coding system which is "isomorphic . . . to the learner's symbolic mode of thinking" (p. 401). According to Conway (1967), the translation of information from one mode to another (coding) is a significant empirical problem. The conceptualization of media research variables in terms of codes and symbol systems, as suggested by Conway (1967), Knowlton (1964), Lumsdaine and May (1965), Norberg (1966), and Salomon (1974) would be consistent with the calls for increased association of media research with communication theory.

The conceptual difficulties and conflicting results in media research have had ramifications on the guidelines for the design of instructional materials. Levie (1973) concluded that "the lack of . . . well-defined variables in pictorial stimuli has . . . hindered progress in understanding what kinds of pictures may have what kinds of effects" (p. 40). Two diametrically opposed orientations to visual design have arisen from the concept of pictorial stimulus complexity, one element in Salomon's (1974) proposed taxonomy.

Hoban, Hoban, and Zisman (1937) proposed that the instructional effectiveness of visual resources depended in part upon the degree to which they approached the reality of experience. According to Norberg (1966), this notion helped set a pattern followed in the audiovisual literature for thirty years. Travers (1964) noted that this proposition had almost the status of a cornerstone in the audiovisual field. Dwyer (1978) collectively entitled this set of theoretical positions as the "realism" theories. Basically, these orientations contend that the more nearly a visual representation resembles its referent (i.e., the higher its "iconicity"--Morris, 1946), the more effective it will be for most instructional purposes. The realism theories encompass Carpenter's (1953) sign-similarity hypothesis and Dale's (1946) Cone of Experiences. Miller (1957) tied a basic principle of stimulus-response theory, stimulus generalization, to the realism position.

The relevant cue hypotheses represent the opposite principle. These hypotheses contend that a reduction of stimulus complexity is beneficial for most learning (Hartmann, 1961; Levie, 1973; Miller, 1957; Rudnick, Porter, & Suydam, 1973; Travers, 1964). Travers (1964) has suggested that "the emphasis on realism . . . is the worship of a false God" (p. 380). The relevant cue position has its origins in information theory and the concept of a limited channel capacity in humans for processing sensory stimulation. The relevant cue idea is congruent with Broadbent's (1958) conclusion that the perceptual system functions as a single channel system accessible to only one source of information at a time. According to Travers (1964), the nervous system handles a wealth of detail by simplifying it.

Miller (1957) described the essential dilemma involved in the two opposing positions. He noted that methods of directing attention to the relevant cues will invariably involve a departure from strict realism and come into conflict with the principle of stimulus generalization. Thus far, neither position has been fully supported by the research (Hedberg & Clark, 1976). Moreover, as Travers (1964) pointed out, "The position of the research scientists and the designers of audiovisual materials are at such opposite poles that it hardly seems possible that both can be correct" (p. 375).

RELATED RESEARCH

The predominant definition of pictorial complexity within the perception research literature has been expressed in terms of the physical parameters of the stimulus. Efforts to quantify the complexity of visual forms have produced a sizable number of studies describing precise methodologies for the generation of random shapes (Attneave, 1957; Dember & Earl, 1957; Den Heyer, 1974; Den Heyer, Ryan, & MacDonald, 1975; Hall, 1969; Stenson, 1966; Terwilliger, 1963; Vitz, 1966). However, it is more difficult to quantify the physical dimensions of the pictorial content common to instructional materials with this same degree of precision. Bergum & Flamm (1979) suggested that bidimensional complexity measures, of the type employed in the evaluation of random figures, may be inadequate for judging the complexity of pictures with tridimensional characteristics: "A complicating factor in the quantification of figural complexity is the matter of how to evaluate depictions of animate objects" (p. 194). Moreover, the thematic complexity, the learner's subjective impressions, or the illustration's function may be more important considerations than the physical parameters in judging instructional effectiveness (Duchastel & Waller, 1979). Nonetheless, variations in the amount of realistic detail, including color, have been the most frequently used method for defining pictorial stimulus complexity in still visuals of an instructional nature (Dwyer, 1978).

Many studies have documented the effects of pictorial complexity on subject preferences in both the research literature on perception (Berlyne, 1958; Dember & Earl, 1957; Hershenon, Munsinger & Keesen, 1965; Vitz, 1966; Wright & Gardner, 1960), and instructional media (Bloomer, 1960; Ibison, 1952; MacLean, 1930; Rudisill, 1952). However, there is a fallacy in basing visual design decisions on subject preferences. Bloomer, 1960; Dwyer, 1971, 1978; Lumsdaine, 1963; Otto and Askov, 1968; and Travers and Alvarado, 1970 have documented that desired instructional outcomes have not been consistent with the expressed preferences for a particular level of pictorial complexity. The research results do suggest that at least two variables (subject age or grade level, and amount of exposure time) interact with the complexity of visual displays to produce differential learning effects.

Subject Age

Studies have shown that rapid increases in pictorial learning skills occur from pre-school through the elementary years. The difficulties of young children with pictorial materials have been demonstrated through inadequate eye movement patterns (Mackworth & Bruner, 1970), and through problems in interpreting dimensional cues and spatial relations (Asso & Wyke, 1970; Brown, 1969).

Elkind, Koegler, and Go (1964) have shown that parts of a picture are perceived at an earlier age than wholes. This result is consonant with Piaget and Inhelder's (1956) finding that young children will reproduce outlines accurately but will improperly locate details within a drawing.

Travers (1969) used subjects varying in age from four to twelve years and discovered a tendency for young children to latch onto one particular object in a picture when presented with repeated short exposures, and to fail to observe other details. Travers also observed a marked improvement across age groups in the ability to report dynamic features of an illustration. Moore and Sasse (1971) used subjects at the third, seventh, and eleventh grade levels and observed a statistically significant difference across grade levels in the amount of immediate recall of picture content.

Presentation Pacing

Levie (1973) has said that "whether it is advisable to reduce the cues to only those which are crucial to the primary learning task . . . or to provide additional cues . . . is largely a function of the amount of time allowed to study the display" (p. 41). Dwyer (1978) and his associates have conducted over one hundred studies on the effectiveness of different types of illustrations. These studies indicated that with fixed exposure times (e.g., experimenter-controlled slide presentations), line drawings have been most effective, while with non-fixed exposure time (e.g., programed instruction), realistic photographs were more effective (Hedberg & Clark, 1976). Corroborating evidence is provided by Hunter (1943), who found that the time required to learn information in a visual display is, in part, dependent upon the complexity or quantity of information it contains, and by Grover (1974), whose data revealed that the recall of complex stimuli improved significantly as the duration of exposure time increased.

INTERPRETING THE FINDINGS

Several authors have attempted to draw conclusions from the many studies dealing with pictorial complexity. Dwyer (1978) summarized his own systematic series of studies on color and realistic detail in still visuals and concluded that these variables are differentially effective, depending on the type of learning outcome.

Other researchers have formed conclusions on the basis of only partial examination of nonrandom and perhaps unrepresentative samples of studies on the topic. Levie (1973) noted that research comparing pictures varying in gross respects (e.g., photographs versus line drawings) usually provide no evidence of differences in learning. The value of realism has been questioned by Boguslavsky (1967), Attneave (1954), Devor and Stern (1970), Gorman (1973), and Rudnick, Porter, and Suydam (1973). On the other hand, support for high iconicity has been provided by Bevan and Steger (1971), Koen (1969), Nelson (1971), Smith (1964), and Spaulding (1955, 1956). Still others have provided evidence which is not so clearcut (Vandermeer, 1954; Fonesca & Bryant, 1960). In reviewing the research findings, Huggins and Entwisle (1974) declared that "more knowledge about the principles of iconic communication is needed" (p. xi).

With respect to graphics in instructional materials, MacDonald-Ross and Smith (1977) concluded that research results have been sufficiently confusing and contradictory and furthermore, that "some kind of preliminary sorting-out is necessary before we can proceed to a 'science of visual instruction'" (p. 5). Burton (1979) proposed a decreased emphasis on *confirmatory* research which tests hypotheses, and has suggested that this "sorting-out" could be accomplished through *exploratory* research which generates hypotheses through an examination of existing research data.

Through the years there have been frequent calls for research syntheses or integrations (Broudy, 1970, 1972; Clark & Angert, 1980; Kuhn, 1962; Petrie, 1976; Randhawa, 1978). Meta-analysis techniques (Glass, 1977) are the most recently developed methodology for accomplishing research integration. Glass has suggested that these techniques are particularly well-suited for resolving controversies arising from conflicting research results. A more conservative approach, however, would be to consider research integration as a form of exploratory rather than confirmatory research.

STATEMENT OF THE PROBLEM

Two distinct but related problems have caused concern within the applied field of educational technology. First, disappointment with much instructional media research has created a sizable literature dealing with media research difficulties and with suggested improvements. Inadequate conceptualization of experimental variables has been frequently blamed for conflicting media research results. Second, concern has been expressed about the decreasing interrelationship between communication theory and educational technology research. Many educational technology researchers have failed to focus on the commonalities that exist among communication models. As a result, some conceptual problems in instructional media research can be traced to a failure to define variables in terms peculiar to communication theory.

One consequence of the above shortcomings is that guidelines for the selection and/or design of instructional materials are often inprecise or contradictory. The conflicting positions of the research scientists and the designers of audiovisual materials have been pointed out.

One proposal has been to increase the emphasis on research which generates hypotheses. Research synthesis, or integration, has been suggested as a methodology for implementing this solution. In addition, researchers have proposed integration as a necessary first step in establishing new media directions. Research integration studies which proceed with variables defined in terms commensurate with communication models could help reaffirm the linkage between communication theory and educational technology.

PURPOSE

The series of studies undertaken by Dwyer (1978) and colleagues represents the only extended and concerted investigation of pictorial stimulus complexity as it relates to static instructional visuals.

Since any conclusions on this topic invariably have leaned heavily on the results of these investigations, an integrative review was deemed to be a useful adjunct in guiding future empirical efforts. Further, although narrative style literature reviews have been quite detailed, thorough, and informative (Dwyer, 1978), it was presumed that a statistical integration as described by Glass (1977) would add a degree of specificity to the numerous conclusions which have already been drawn regarding this research. Finally, the basic similarities among all the studies in the series provided an excellent data base for testing the feasibility of applying certain meta-analysis techniques (Glass, 1977) to the entire body of research in the topic area.

METHODOLOGY

Sample

According to Glass (1977), the spirit of meta-analysis is that statistical methods aid perception, and the question therefore of how large a sample size is adequate for a meta-analysis ought properly to be rephrased to: "How many studies can be read and integrated without resorting to statistical methods to reveal aggregate findings and relationships?" (p. 362). The number, he concluded, is probably quite small. As proposed by Glass, the initial step in a meta-analysis is the computation of a common measure of treatment effectiveness, known as the *effect-size*. An effect-size is calculated most directly by taking the difference between a treatment and control group mean and then dividing this difference by the control group standard deviation. Although Glass described methods for recovering data and for computing estimates of effect-sizes and "pseudo" effect-size values in the absence of some data, this preliminary investigation is limited to those studies containing data necessary for the direct computation of effect-size measures.

All available published and unpublished reports of research in this series were scrutinized for appropriate data and an attempt made to recover original data where necessary. As a result of this delimitation, complete data were available from twenty-three publications, several of which were found to contain duplicate results (see Appendix A). Although Dwyer (1978) indicated that over 100 such studies have been conducted, the age of the bulk of these studies thwarted further efforts at recovery.

Procedure

All studies were coded for subject grade level, type of treatment illustration, color, type of criterion measure, time of testing (immediate post or delayed post), and method of presentation (i.e., internally paced as in programed instruction, or externally paced as in researcher-controlled slide/audiotape presentations). In addition, other variables peculiar to particular studies (e.g., image size, student preferences, I.Q., effects of prior knowledge) were coded. This coding process was greatly simplified by virtue of the similarities through all studies in terms of treatment content, criterion measures, and illustration types. (For a more detailed description of these variables and procedures, see Dwyer, 1978). The coding system was not significantly affected either by modifications to treatment content, illustrations, or criteria; or by the omission of certain illustrations and criteria from some studies.

All told, 1,329 effect-size measures were generated from the available data, and the effect-size values, rather than individual studies, served as the units of analysis. The large number of effect-size measures from a relatively small number of studies was a result of the method of computation. Each effect-size measure was a comparison of a treated control group receiving verbal information versus an experimental group receiving the same verbal information with the addition of an illustration. Since each measure was computed while holding all other variables at a particular level, studies incorporating multiple illustration types and several levels of numerous additional variables yielded multiple effect-size measures. The 1,329 effect-size measures represent about 4,800 treated and untreated subjects across five grade levels (grades 9-12, and college level).

The relationships between the effect-size values and the coded variables were examined by aggregating mean effect-sizes across various crosscuts of the data. In addition, in accordance with procedures recommended by Glass (1977), multiple regression techniques were also utilized for their descriptive force in revealing potential relationships among the coded variables.

RESULTS

By averaging the effect-size values across all studies and including all types of illustrations, criteria, and grade levels, we can generalize a mean effect-size of 0.65, i.e., the average subject receiving some form of illustrated treatment was about two-thirds standard deviation more improved in terms of learning outcome than the average control group member receiving only the verbal treatment. This relationship is depicted in Figure 1.

- - - - - - - - - - - - - - - - - -

Insert Figure 1 about here

- - - - - - - - - - - - - - - - - -

When the mean effect-size values and the coded variables were examined separately by type of illustration, grade level, type of criterion measure, type of pacing, and color, the results depicted in Table 1 were obtained. The regression analysis revealed the possibility of interactions of grade level with the type of criterion measure, as well as grade level with the type of illustration. Two examples of these potential relationships for externally paced presentations utilizing black and white illustrations are presented in Figures 2 and 3. These data are consistent with the information revealed in Table 1, and additionally describe fluctuations in mean effect-size rankings for criteria and illustrations by grade level changes.

effect-size values give initial indications of crude interval distances between the scaled entries. These findings are consistent with Dwyer's (1978) conclusion that the realism continuum for visual illustrations does not successfully predict learning efficiency for all educational objectives with all types of learners. Moreover, the data also suggest that it may be possible to impart a degree of specificity to the scale positioning, thus providing a basis for more specific and probing hypotheses regarding the extent of superiority of one illustration type over another. Such quantitative positioning may also afford the opportunity for comparisons across continuums.

- - - - - - - - - - - - - - - - - - -

Insert Figure 4 about here

- - - - - - - - - - - - - - - - - - -

Dwyer (1978) has also concluded that in many instances the control group was found to be superior to the treatment groups in achievement on particular tasks, and for specific students. Without disputing the validity of this conclusion, our analysis revealed that at least one illustrated treatment (and usually more) in every grade level by criterion comparison proved superior to the verbal control group. Thus, while there were several instances where negative effect-size values were obtained, indicating a negative effect for some illustrated treatments, there was at least one type of illustrated treatment that always ranked superior to verbal treatment alone. Table 2 presents the results of this analysis for externally paced presentations. The absence of

- -

Insert Table 1 and Figures 2 and 3 about here

- -

The potential utility of the meta-analytic style of research integration may perhaps be assessed by brief comparisons of the present data with a few previous conclusions drawn by Dwyer (1978) and others. A variety of realism or abstract/concrete continuums have been developed to represent a proposed scale of effectiveness for instructional materials. These scales extend from oral symbols (digital signs) at the highly abstract level to three-dimensional objects (iconic signs) at the most concrete level. The implication is that the most realistic representation (i.e., the most concrete) will be most beneficial for most instructional purposes.

Two points regarding these scales merit further analysis. First, the suggestion has been made by Wheelbarger (1970), Dwyer (1978) and others, that a variety of visual continuums may exist depending upon specific variables and conditions. Second, Haynie (1978) pointed out that existing continuums attempt to relate the scaled entries on an ordinal basis only, and not on an interval scale. Thus, inferences as to the extent of separation between entries heretofore have not been possible. Figure 4 presents findings from our analysis which speak directly to these points. By comparing the three continuums based upon mean effect-size values to Dwyer's visual continuum (also Figure 4), we can illustrate that a variety of continuums may indeed exist, depending upon the level of analysis. Additionally, the mean negative effect-size values illustrates the superiority of an illustrated treatment in every instance. Moreover, when we draw a hypothetical division in Dwyer's visual continuum (see Figure 4) such that illustrations 1-4 represent the least complex conditions and illustrations 5-8 the most complex conditions, our comparison of mean effect-size values indicates that:

(a) for externally paced presentations, the *most* effective illustration was one of the least complex in every grade level by criterion comparison (see Table 2), and

- - - - - - - - - - - - - - - - - -

Insert Table 2 about here

- - - - - - - - - - - - - - - - - -

(b) for externally paced presentations, the *least* effective illustration was one of the most complex in all but two grade levels by criterion comparisons (see Table 3).

- - - - - - - - - - - - - - - - - -

Insert Table 3 about here

- - - - - - - - - - - - - - - - - -

Table 2 also provides statistical support for Dwyer's (1978) conclusion that "for students in different grade levels, the same visuals are not equally effective in increasing achievement of identical educational objectives" (p. 95). As demonstrated by this table, the most effective illustration for every criterion had the lowest mean effect-size value at the college level.

Invariably, any comparative analysis of illustration effectiveness will lead to the persistent question of the value of color as a cueing technique. With our limited data, a further analysis of Tables 2 and 3 with regard to this question hints at the potential strength of the color cue. Color illustrations predominated as both the most and the least effective treatment presentation, providing the highest mean effect-size values on 13 of 20 occasions and the lowest mean effect-size values on 12 of 20 comparisons. Plausibly, color may be either highly facilitative or highly interferent for accomplishing given educational tasks. As yet, no discernible pattern of influence for either task or grade level is evident in Tables 2 and 3 with respect to this variable. Dwyer's (1978) conclusions regarding this issue are alternately bold and cautious. Consider these two quotations:

(a) "There is an increasing amount of empirical evidence which tends to support the contention that the addition of color in visual illustrations does improve student achievement of specific educational objectives" (p. 150);

(b) "For specific students and for specific educational objectives, the use of color in certain types of visuals presented via the slide/audiotape format appears to be an important instructional variable in improving student achievement. For other educational objectives, however, the added cost of color may not be justified from the instructional effectiveness standpoint" (p. 96).

Although Figure 5 suggests consistent supremacy of color illustrations over their black and white counterparts when results are generalized across grade levels and criteria for externally paced presentations, the danger of overgeneralization at the macro level of analysis becomes apparent when Figure 5 is compared with Figure 6. In the latter figure,

- -

Insert Figures 5 and 6 about here

- -

mean effect-size comparisons are again presented for identical black and white versus color illustrations, but within an internally paced presentation format. Additionally, for Figure 6, the focus has narrowed to a single criterion (the comprehension test), and to one specific grade (the college level). As shown by the data, the use of color in this situation serves to increase the *ineffectiveness* of three types of illustrations and to increase the *effectiveness* of a fourth type.

CONCLUSION

The data reported herein should be regarded as only a preliminary and partial investigation of the topic of pictorial stimulus complexity, and as such, our results are not conclusion oriented. Although it is likely that more thorough aggregation will modify these findings, the data do provide indications of possible trends which may ultimately be sustained by more complete analyses, and which may help to generate experimental investigation in the interim.

Since our analysis was limited to variables common to all studies, more finite analyses of specific student attributes or treatment variations is not always feasible at the macro level of research integration. However, this condition is not always restrictive, since a molar level of analysis has genuine value for certain levels of educational decision making. While important individual differences undoubtedly are obscured to some extent in this type of analysis, there are nevertheless instances where the specificity of information is sufficient for generating hypotheses for further research.

REFERENCES

Allen, W. H. Instructional media research: Past, present, and future. AV Communication Review, 1971, 19, 5-18.

Asso, D., & Wyke, M. Visual discrimination and verbal comprehension of spatial relations by young children. British Journal of Psychology, 1970, 61, 99-107.

Attneave, F. Some informational aspects of visual perception. Psychological Review, 1954, 61, 183-193.

Attneave, F. Physical determinants of the judged complexity of shapes. Journal of Experimental Psychology, 1957, 53, 221-227.

Barr, A., Goodknight, J., Sall, J., & Helwig, J. SAS user's guide. Raleigh, North Carolina: SAS Institute, Inc., 1979.

Bergum, B. O., & Flamm, L. E. Reversibility and apparent tridimensionality. Bulletin of the Psychonomic Society, 1979, 14, 193-196.

Berlo, D. K. The process of communication. New York: Holt, Rinehart, and Winston, 1960.

Berlyne, D. E. The influence of complexity and novelty in visual figures on orienting responses. Journal of Experimental Psychology, 1958, 55, 289-296.

Bevan, W., & Steger, J. A. Free recall and abstractness of stimuli. Science, 1971, 172, 597-599.

Bloomer, R. H. Children's preferences and responses as related to styles and themes of illustration. Elementary School Journal, 1960, 60, 334-340.

Boguslavsky, G. W. Study of characteristics contributing to the effectiveness of visual demonstrations. (Final Report Project No. 5-0458, Grant No. 7-42-1070-178). Troy, New York: Renssaeler Polytechnic Institute, April, 1967.

Bracht, G. H. Experimental factors related to aptitude-treatment interactions. Review of Educational Research, 1970, 40, 627-645.

Broudy, H. S. On knowing with. In H. S. Broudy (Ed.), Proceedings of the philosophy of education society: Studies in philosophy and education. Edwardsville, Illinois: Southern Illinois Univ., 1970. pp 89-103.

Broudy, H. S. The real world of the public schools. New York: Harcourt, 1972.

Brown, L. The 3-D reconstruction of a 2-D visual display. Journal of Genetic Psychology, 1969, 115, 257-262.

Burton, N. W. Assessment as exploratory research: A theoretical overview. Educational Technology, 1979, 19(2), 5-11.

Carpenter, C. R. Psychological concepts and audiovisual instruction. AV Communication Review, 1957, 5, 361-369.

Clark, F. E. & Angert, J. F. Inadequacies in media research. Instructional Innovator, 1980, 25(1), 36-37.

Conway, J. K. Multiple-sensory modality communications and the problem of sign types. AV Communication Review, 1967, 15, 371-383.

Cronbach, L. J., & Snow, R. E. Aptitudes and instructional methods. New York: Irvington, 1977.

Dale, E. Audio-visual methods in teaching. New York: Dryden Press, 1946.

Dance, F. E. X. The "concept" of communication. The Journal of Communication, 1970, 20, 201-210.

Dember, W. H., & Earl, R. W. Analysis of exploratory, manipulatory, and curiosity behaviors. Psychological Review, 1957, 64, 91-96.

Den Heyer, K. Structural stimulus complexity: One factor influencing the clarity of iconic storage. Acta Psychologica, 1974, 38(1), 21-31.

Den Heyer, K., Ryan, B., & MacDonald, J. The relationship between structural stimulus complexity and clarity of iconic storage under a backward masking paradigm. Acta Psychologica, 1976, 40(3), 189-198.

Deutschmann, P. J., Barrow, L. C., Jr., & McMillan, A. The efficiency of different modes of communication. AV Communication Review, 1961, 9, 263-270.

Devor, G. M., & Stern, C. Objects versus pictures in the instruction of young children. Journal of School Psychology, 1970, 8, 77-81.

Duchastel, P., & Waller, R. Pictorial illustration in instructional texts. Educational Technology, 1979, 19(11), 20-25.

Dwyer, F. M. Student perceptions of the instructional effectiveness of black & white and colored illustrations. The Journal of Experimental Education, 1971, 40, 28-34.

Dwyer, F. M. Strategies for improving visual learning. State College, Pa.: Learning Services, 1978.

Elkind, D., Koegler, R., & Go, E. Studies in perceptual development: II part-whole perception. Child Development, 1964, 35, 81-90.

Fleming, M. L. Media research prospects: Considerations from a perceptual point of view. In G. Salomon and R. E. Snow (Eds.), Viewpoints, (Bulletin of the School of Education, Indiana University), 1970, 46, 119-136.

Fonesca, L., & Bryant, K. Comparison of pictorial symbols -- an experiment in rural Brazil. Bulletin 30. Madison, Wisconsin: College of Agriculture, University of Wisconsin, 1960.

Gibson, J. J. A theory of pictorial perception. AV Communication Review, 1954, 2, 3-23.

Glass, G. V. Primary, secondary and meta-analysis of research. Educational Researcher, 1976, 5, 3-8.

Glass, G. V. Integrating findings: The meta-analysis of research. Review of Research in Education, 1977, 5, 351-379.

Gorman, D. A. Effects of varying pictorial detail and presentation strategy on concept formation. AV Communication Review, 1973, 21, 337-350.

Grover, P. L. Effect of varied stimulus complexity and duration upon immediate recall of visual material in a serial learning task. AV Communication Review, 1974, 22, 439-452.

Hall, A. C. Measures of the complexity of random black and white and coloured stimuli. Perceptual and Motor Skills, 1969, 29, 773-774.

Hartmann, F. R. Single and multiple channel communication: A review of research and a proposed model. AV Communication Review, 1961, 9, 235-261.

Hawkridge, D. G. Media taxonomies and media selection. Paper prepared for the Institute of Educational Technology. The Open University, Milton Keynes, England, 1973.

Haynie, W. J., III. The instructional effectiveness of realism and enhancement of illustrations as related to visual continuum theories (Doctoral dissertation, The Pennsylvania State University, 1978). Dissertation Abstracts International, 1979, 39, 4666A-4667A. (University Microfilms No. 7902608)

Hedberg, J. G., & Clark, R. E. Realism in pictorial instruction: What the research says. Educational Technology, 1976, 16, 46-47.

Heidt, E. U. Media and learner operations: The problem of a media taxonomy revisited. British Journal of Educational Technology, 1977, 8, 11-26.

Hershenon, M., Munsinger, H., & Keesen, W. Preference for shapes of intermediate variability in the newborn human. Science, 1965, 147, 630-631.

Hill, H. E. Communication research and instructional technology. Educational Communication and Technology Journal, 1978, 26, 47-54.

Hoban, C. F., Hoban, C. F. Jr., & Zisman, S. B. Visualizing the curriculum. New York: The Dryden Press, Inc., 1937.

Huggins, W. H., & Entwisle, D. R. Iconic communication: An annotated bibliography. Baltimore: The Johns Hopkins University Press, 1974.

Hunter, W. S. Visually controlled learning as a function of time and intensity of stimulation. Journal of Experimental Psychology, 1943, 31, 423-429.

Ibison, R. A. Differential effects on the recall of textual materials associated with the inclusion of colored and uncolored illustrations. Unpublished doctoral dissertation, Indiana University, 1952.

Isaac, S., & Michael, W. B. Handbook in research and evaluation. San Diego, CA: Edits Publishers, 1971.

Jackson, G. B. Methods for reviewing and integrating research in the social sciences. Final report, National Science Foundation Grant # DIS 76-20398. Washington, D.C.: Social Research Group, George Washington University, April 1978.

Knowlton, J. Q. A conceptual scheme for the audiovisual field. In Viewpoints, (Bulletin of the School of Education, Indiana University), 1964, 40, 1-42.

Koen, F. Verbal and nonverbal mediators in recognition memory for complex visual stimuli. USOE Bureau of Research, Grant BR-6-1784, February, 1969. Contract OEC-3-6-061784-0508. (ERIC Document Reproduction Service No. ED 029 349)

Kuhn, T. S. Structure of scientific revolutions. Chicago: Univ. of Chicago Press, 1962.

Levie, W. H. Pictorial research: An overview. In W. H. Levie (Ed.), Viewpoints, (Bulletin of the School of Education, Indiana University), 1973, 49, 37-45.

Levie, W. H. A prospectus for instructional research on visual literacy. Educational Communications and Technology Journal, 1978, 26, 25-36.

Littlejohn, S. W. Theories of human communication. Columbus, Ohio: Charles E. Merrill, 1978.

Lumsdaine, A. A. Instruments and media of instruction. In N. L. Gage (Ed.), Handbook of Research on Teaching. Chicago: Rand McNally, 1963, pp. 583-682.

Lumsdaine, A. A., & May, M. A. Mass communication and educational media. In P. R. Fransworth (Ed.), Annual Review of Psychology, 1965, 16, Palo Alto, California.

MacDonald-Ross, M., & Smith, E. Graphics in text: A bibliography. (IET Monograph No. 6). Institute of Educational Technology, The Open University, Milton Keynes, England, 1977.

MacLean, W. P. A comparison of colored and uncolored pictures. Educational Screen, 1930, 9, 196-199.

Mackworth, N. H., & Bruner, J. S. How adults and children search and recognize pictures. Human Development, 1970, 13, 149-177.

Mielke, K. W. Renewing the link between communications and educational technology. AV Communication Review, 1972, 20, 357-399.

Miller, N. E. (Ed.) Graphic communication and the crisis in education. By N. E. Miller in collaboration with W. A. Allen, et al., AV Communication Review, 1957, 5, 1-120.

Moore, D. M., & Sasse, E. B. Effect of size and type of still projected pictures on immediate recall of content. AV Communication Review, 1971, 19, 437-450.

Morris, C. E. Signs, language and behavior. New York: Prentice-Hall, Inc., 1946.

Mortensen, C. D. Communication: The study of human interaction. New York: McGraw-Hill, 1972.

Nelson, K. E. Memory development in children: Evidence from nonverbal tasks. Psychonomic Science, 1971, 25, 346-348.

Norberg, K. D. Iconic signs and symbols in audio-visual communication. Sacramento, Calif.: Sacramento State College, 1966. (ERIC Document Reproduction Service No. ED 013 371)

Otto, W., & Askov, E. The role of color in learning and instruction. Journal of Special Education, 1968, 2, 155-165.

Parkhurst, P. E. Generating meaningful hypotheses with aptitude-treatment interactions. AV Communication Review, 1975, 23, 171-196.

Petrie, H. C. Do you see what I see? The epistemology of interdisciplinary inquiry. Educational Researcher, 1976, 5(2), 9-15.

Piaget, J., & Inhelder, B. The child's conception of space. London: Routlege and Kegan Paul, 1956.

Randhawa, B. S. Visual trinity: An overview. In B. S. Randhawa & W. E. Coffman (Eds.), Visual learning, thinking, and communication. New York: Academic Press, 1978, 191-211.

Rudisill, M. Children's preferences for color versus other qualities in illustrations. The Elementary School Journal, 1952, 52, 444-451.

Rudnick, M. F., Porter, M. C., & Suydam, E. L. Pictorial stimulus variables. In W. H. Levie (Ed.), Viewpoints, (Bulletin of the School of Education, Indiana University), 1973, 49.

Salomon, G. What is learned and how it is taught: The interaction between media, message, task, and learner. Seventy-third yearbook of the National Society for the Study of Education. Chicago: NSSE, 1974, 383-406.

Schramm, W. Big media, little media. Beverly Hills, Ca.: Sage Publications, Inc., 1977.

Shannon, E. E., & Weaver, W. The mathematical theory of communication. Urbana, Ill.: The University of Illinois Press, 1949.

Smith, W. H. Visual analogy in nonverbal communications (Doctoral dissertation, Indiana University, 1965). Dissertation Abstracts, 1965, 25, 2595A. (University Microfilms No. 65-10891)

Spaulding, S. Research on pictorial illustration. AV Communication Review, 1955, 3(1), 35-45.

Spaulding, S. Communication potential of pictorial illustrations. AV Communication Review, 1956, 4(1), 31-46.

Stenson, H. H. The physical factor structure of random forms and their judged complexity. Perception and Psychophysics, 1966, 1, 303-310.

Terwilliger, R. F. Pattern complexity and affective arousal. Perceptual and Motor Skills, 1963, 17, 387-395.

Travers, R. M. W. The transmission of information to human receivers. AV Communication Review, 1964, 12, 373-385.

Travers, R. M. W. A study of the advantages and disadvantages of using simplified visual presentations in instructional materials. (Final Report, Dept. of HEW, USOE), 1969. (ERIC Document Reproduction Service No. ED 031 951)

Travers, R. M. W., & Alvarado, V. The design of pictures for teaching children in elementary school. AV Communication Review, 1970, 18, 47-64.

Vandermeer, A. W. Color vs. black and white in instructional films. AV Communication Review, 1954, 2, 121-134.

Westley, B. H., & MacLean, M. S., Jr. Conceptual model for communications research. In N. L. Harper (Ed.), Human communication. New York: MSS Information Corporation, 1974.

Wheelbarger, J. J. An investigation of the role of pictorial complexity in visual perception (Doctoral dissertation, University of Virginia, 1970). Dissertation Abstracts International, 1971, 31, 5864A. (University Microfilms No. 71-6636)

Wright, B., & Gardner, B. Effect of color on black and white pictures. Perceptual and Motor Skills, 1960, 11, 301-304.

Table 1

Mean Effect-Size Values By Coded Variable

(In Standard Deviation Units)

Variable	n	Mean Effect-Size[a]
Illustrations		
Simple Line Drawing (B&W)	235	.71 ± .06
Simple Line Drawing (color)	112	1.04 ± .07
Shaded Detailed Drawing (B&W)	173	.76 ± .05
Shaded Detailed Drawing (color)	112	1.19 ± .10
Model Photograph (B&W)	135	.46 ± .06
Model Photograph (color)	112	.68 ± .08
Realistic Photograph (B&W)	178	.39 ± .05
Realistic Photograph (color)	152	.39 ± .06
Grade Levels		
Ninth	190	1.00 ± .06
Tenth	406	.64 ± .04
Eleventh	160	1.00 ± .06
Twelfth	140	.80 ± .06
College	433	.33 ± .03
Criteria		
Drawing Test	273	.91 ± .05
Identification Test	273	.63 ± .04
Terminology Test	261	.54 ± .05
Comprehension Test	253	.27 ± .05
Presentation Pace		
External	942	.77 ± .03
Internal	387	.36 ± .04
Color		
Black and White	721	.59 ± .03
Color	608	.72 ± .04

[a] With an indication of the approximate standard error of the mean. Thus, the interval indicated for each mean effect-size value has a confidence coefficient of about two-thirds.

Table 2

Most Effective Illustration for Externally

Paced Presentations

Criterion	Grade Level				
	9	10	11	12[a]	College[b]
Drawing Test	Simple Line Drawing (B&W) ES = 2.60	Shaded Detailed Drawing (color) ES = 2.07	Shaded Detailed Drawing (color) ES = 1.39	Shaded Detailed Drawing (color) ES = .92	Simple Line Drawing (B&W) ES = .83
Identification Test	Shaded Detailed Drawing (color) ES = 1.38	Shaded Detailed Drawing (color) ES = 1.66	Shaded Detailed Drawing (color) ES = 1.63	Shaded Detailed Drawing (color) ES = 1.31	Simple Line Drawing (color) ES = 1.08
Terminology Test	Shaded Detailed Drawing (color) ES = 1.07	Shaded Detailed Drawing (B&W) ES = 1.37	Shaded Detailed Drawing (B&W) ES = 1.37	Shaded Detailed Drawing (color) ES = 2.88	Simple Line Drawing (B&W) ES = .30
Comprehension Test	Simple Line Drawing (B&W) ES = .73	Simple Line Drawing (color) ES = 1.19	Shaded Detailed Drawing (B&W) ES = 1.21	Shaded Detailed Drawing (color) ES = 1.19	Simple Line Drawing (color) ES = .56

Note. ES = mean effect-size value.

[a] No treatment group in this grade level utilized realistic color photographs.

[b] Several treatments in this grade level with only one effect-size value.

Table 3

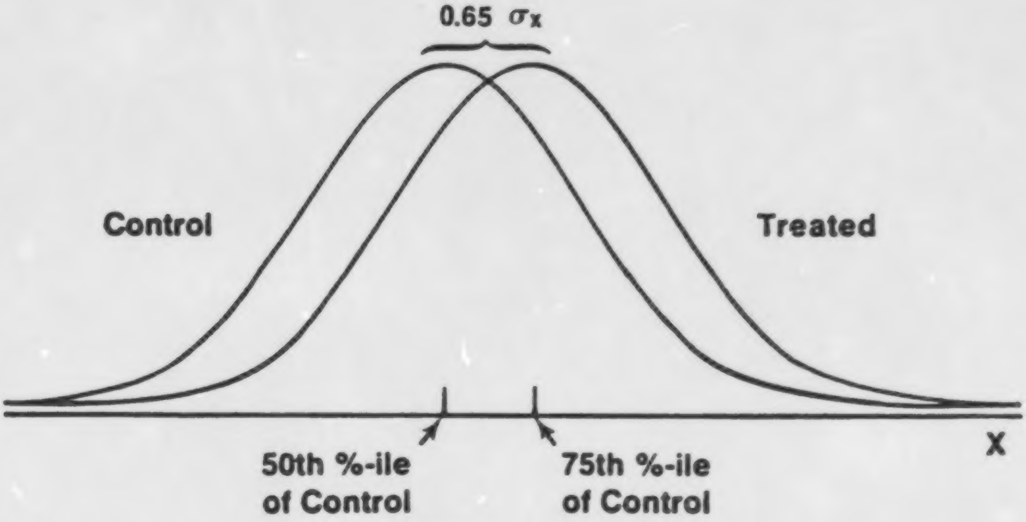
Least Effective Illustration for Externally Paced Presentations

Criterion	Grade Level				
	9	10	11	12[a]	College[b]
Drawing Test	Model Photograph (B&W) ES = 1.26	Realistic Photograph (color) ES = .55	Realistic Photograph (color) ES = .60	Model Photograph (color) ES = .30	Realistic Photograph (color) ES = .08
Identification Test	Realistic Photograph (B&W) ES = .32	Realistic Photograph (color) ES = .50	Model Photograph (color) ES = .63	Simple Line Drawing (B&W) ES = .41	Realistic Photograph (B&W) ES = -.09
Terminology Test	Realistic Photograph (B&W) ES = .15	Realistic Photograph (color) ES = .11	Realistic Photograph (color) ES = .24	Model Photograph (color) ES = .86	Realistic Photograph (color) ES = -.35
Comprehension Test	Shaded Detailed Drawing (B&W) ES = -.24	Model Photograph (B&W) ES = .76	Realistic Photograph (color) ES = -.61	Realistic Photograph (B&W) ES = .18	Realistic Photograph (color) ES = -.40

Note. ES = mean effect-size value.

[a] No treatment group in this grade level utilized realistic color photographs

[b] Several treatments in this grade level with only one effect-size value.



Average Effect Size: 0.65 σ_x
Standard Deviation of Effect Size: 0.82 σ_x

Figure 1. Normal curves showing the aggregate effect of illustrated treatments in relation to treated control groups.

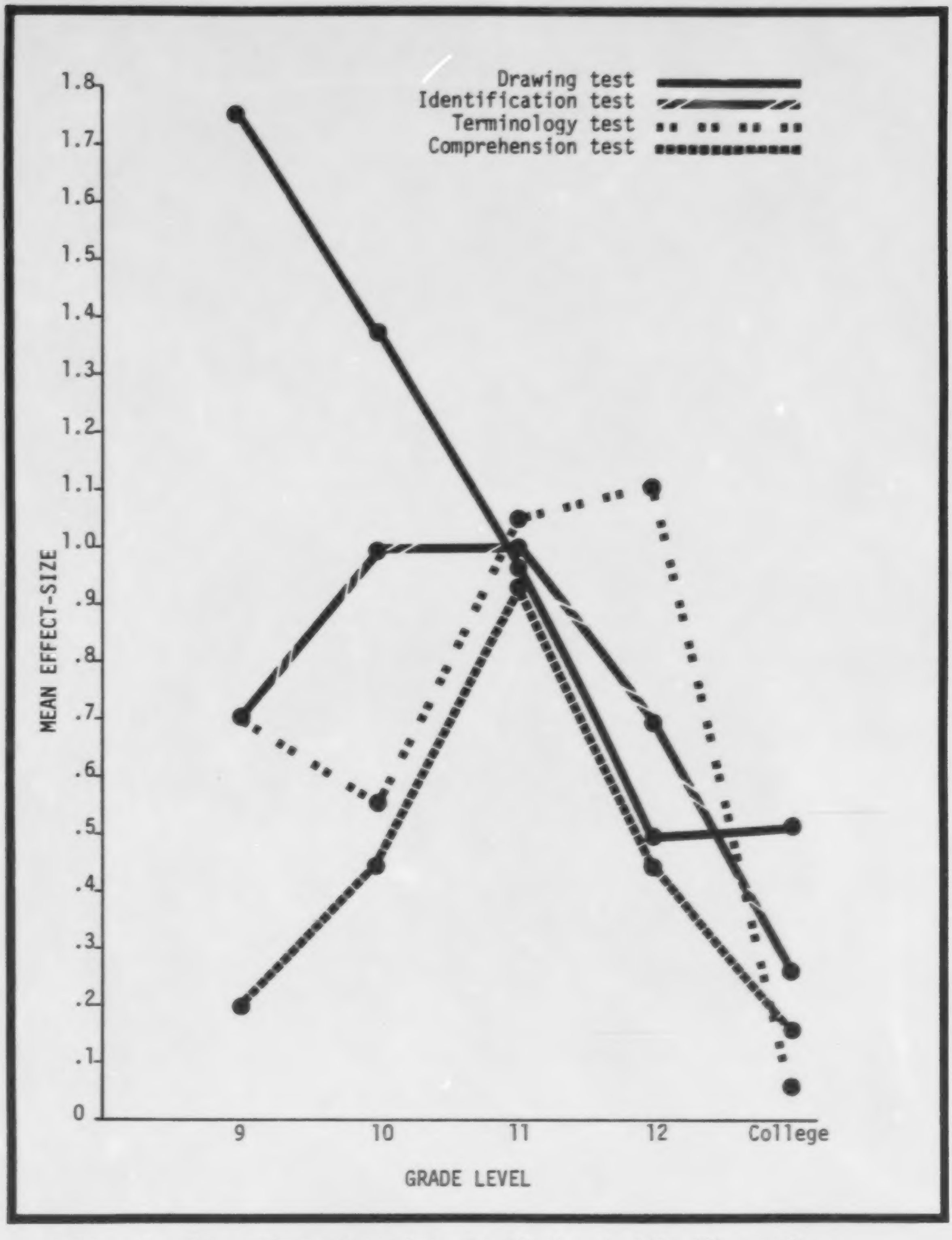


Figure 2. Mean effect-size values for black and white illustrations by criterion and grade level. (For externally paced presentations.)

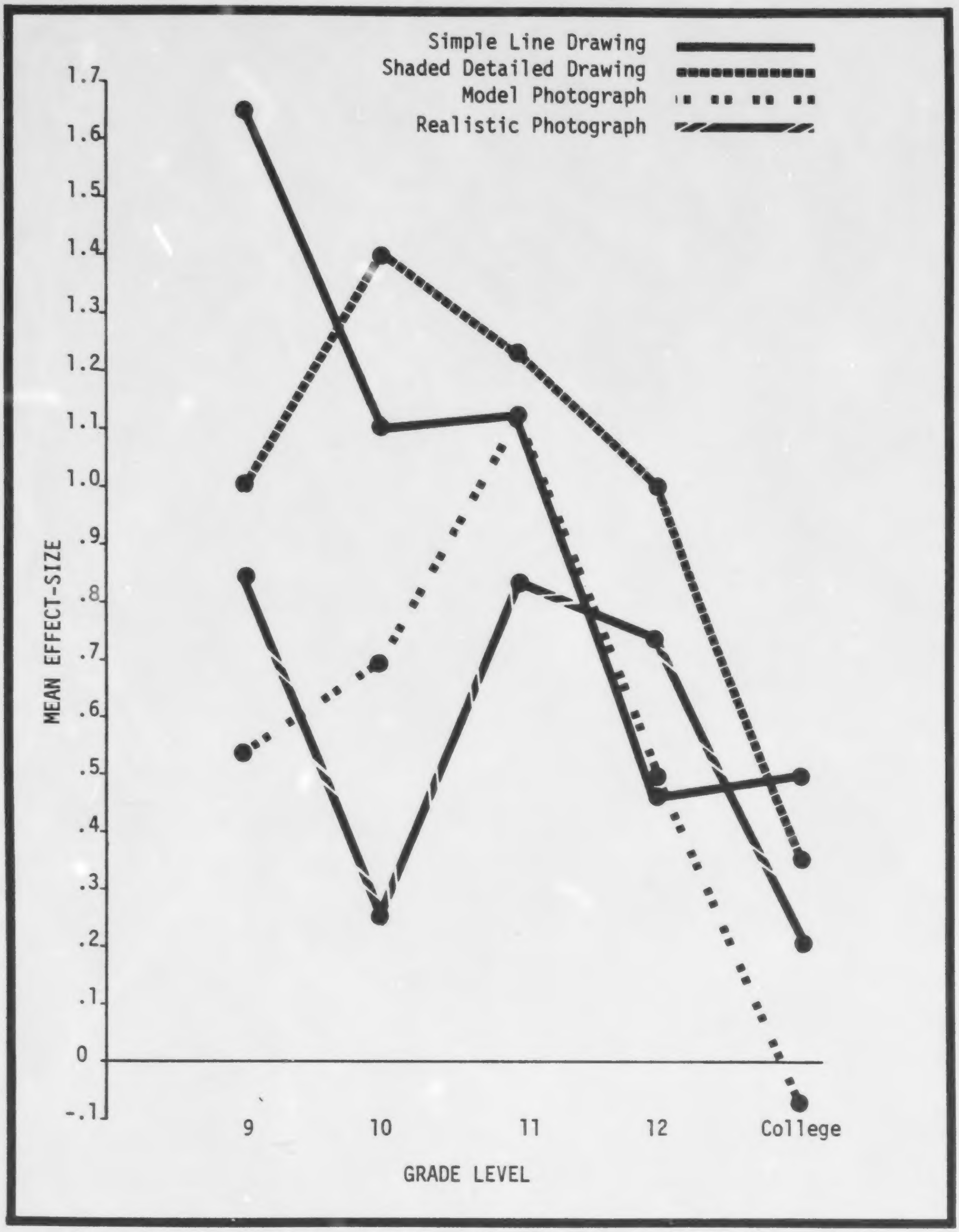


Figure 3. Mean effect-size values for all criteria by black and white illustration and grade level. (For externally paced presentations.)

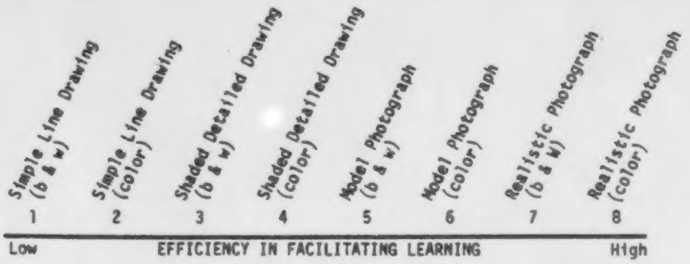

Simple Line Drawing (b & w)
Simple Line Drawing (color)
Shaded Detailed Drawing (b & w)
Shaded Detailed Drawing (color)
Model Photograph (b & w)
Model Photograph (color)
Realistic Photograph (b & w)
Realistic Photograph (color)
1
2
3
4
5
6
7
8
Low
EFFICIENCY IN FACILITATING LEARNING
High

Plate 1. Realism continuum for illustrations in accordance with the "realism theories" (Dwyer, 1978).

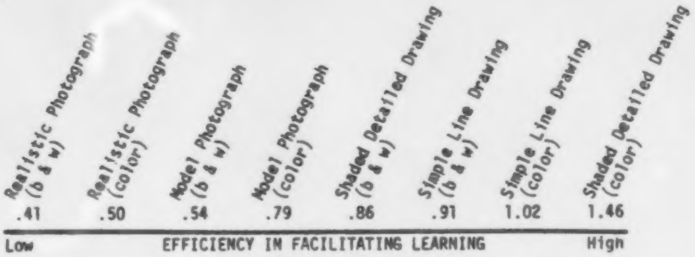


Plate 2. Realism continuum for illustrations generalized across four criteria and five grade levels.

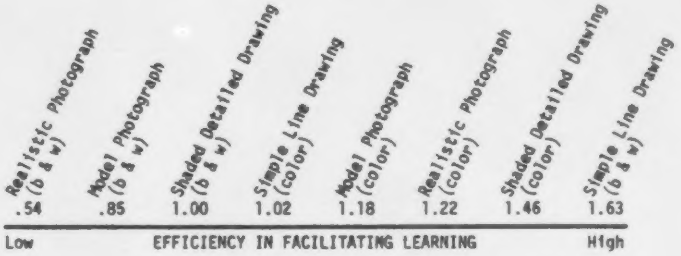


Plate 3. Realism continuum for illustrations generalized across four criteria for the ninth grade.

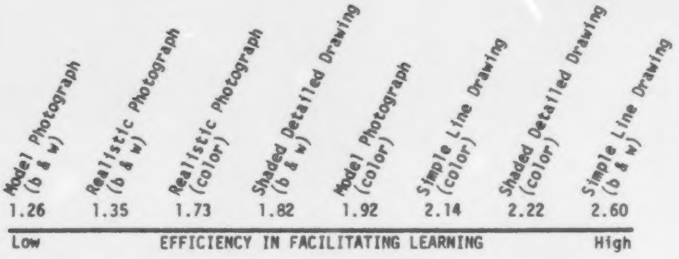


Plate 4. Realism continuum for illustrations specific to the drawing test criterion for the ninth grade.

Figure 4. Comparison of Dwyer's (1978) visual continuum with three visual continuums derived from mean effect-size values.

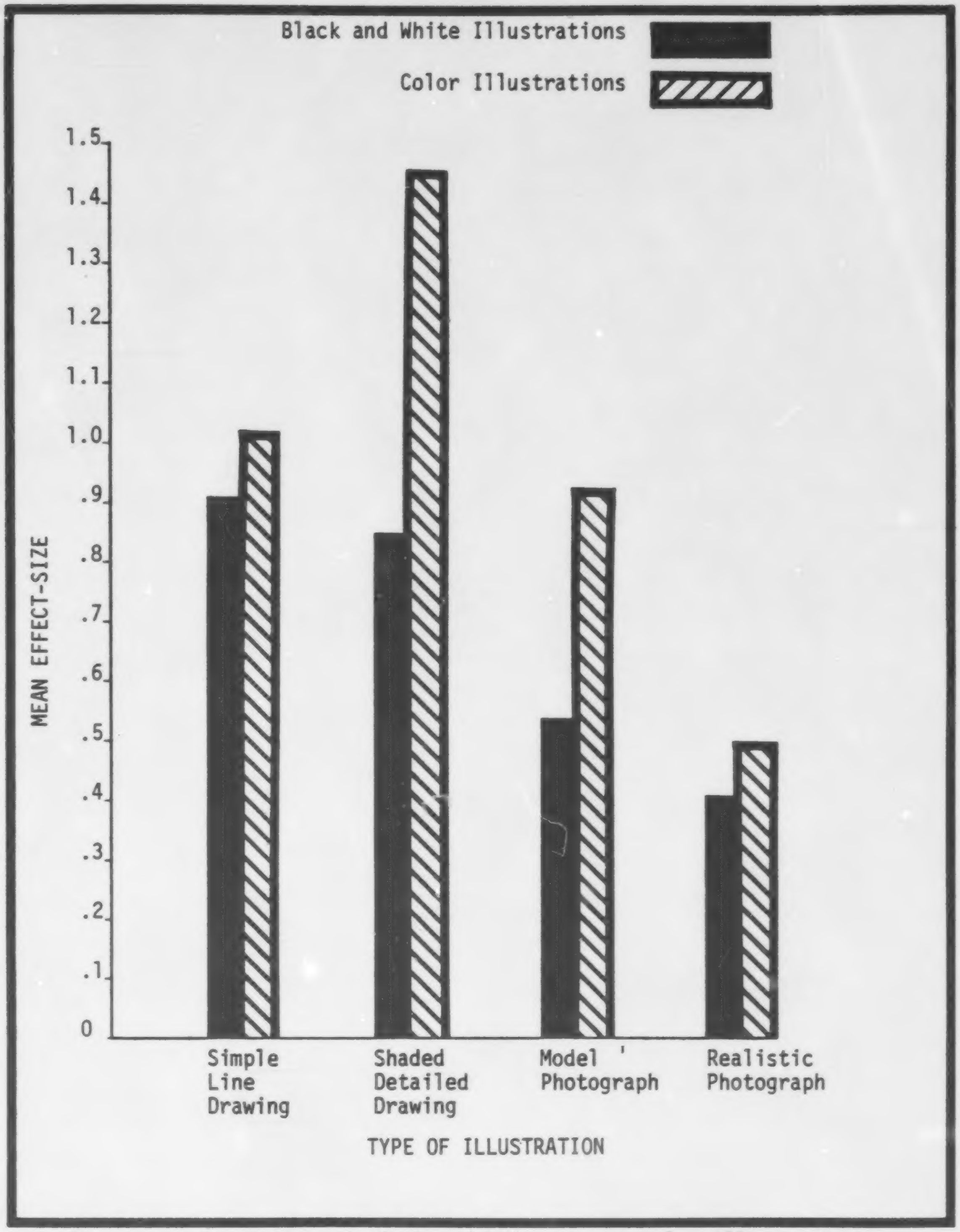


Figure 5. Comparison of black and white versus color illustration mean effect-size values for all criteria and grade levels. (For externally paced presentations.)

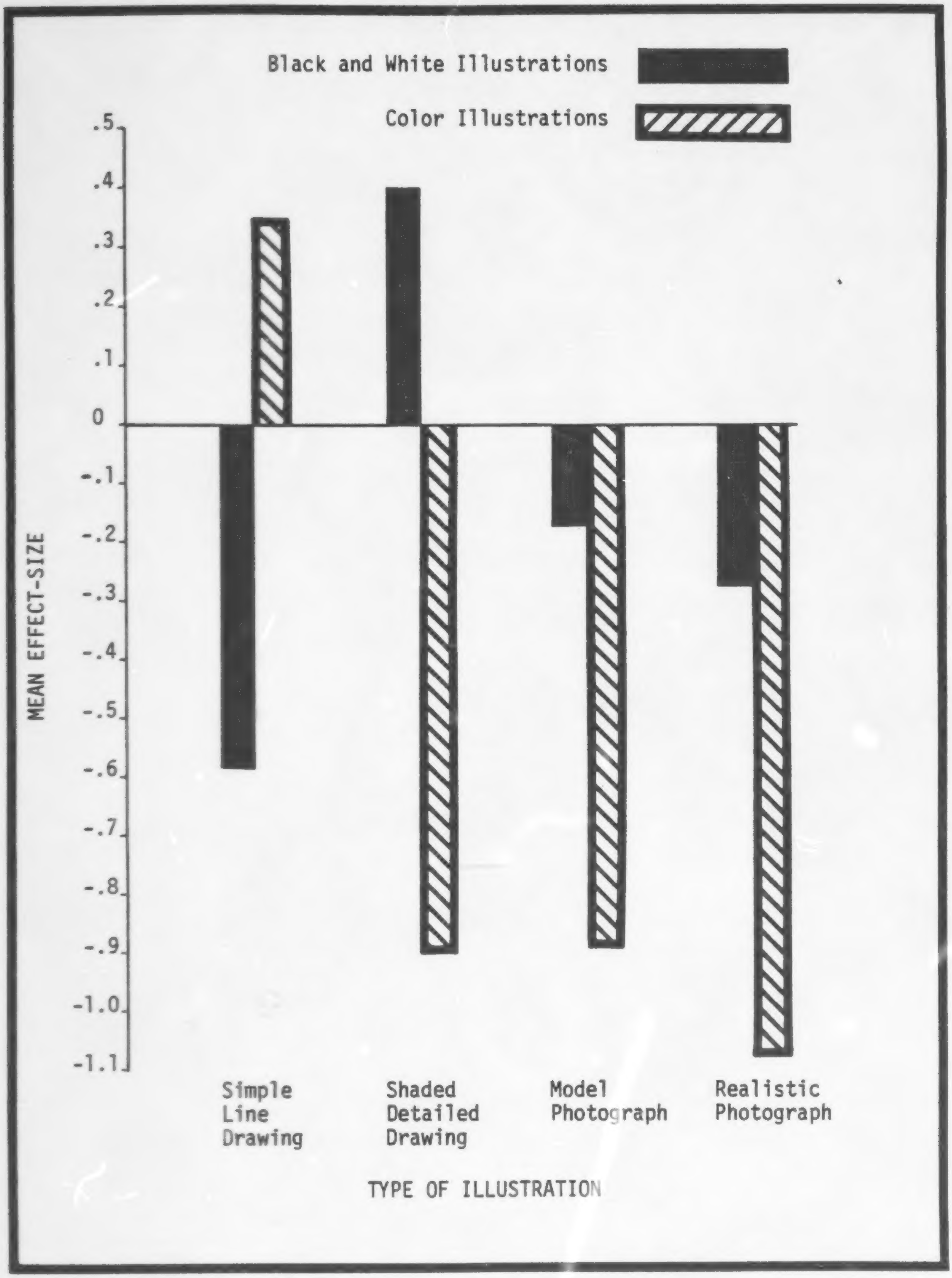


Figure 6. Comparison of black and white and color illustration mean effect-size values for the comprehension criterion for college level students. (For internally paced presentations.)

Appendix A: Publications Comprising the Sample

Arnold, T. C., & Dwyer, F. M. Realism in visualized instruction. *Perceptual and Motor Skills*, 1975, *40*, 369-370.

Dwyer, F. M. Adapting visual illustrations for effective learning. *Harvard Educational Review*, 1967, *37*, 250-263.

Dwyer, F. M. *An experimental evaluation of visual illustrations used to complement programed instruction*. University Park, The Pennsylvania State University, University Division of Instructional Services, 1967. (ERIC Document Reproduction Service No. ED 019 871)

- Contains data found in:

  Dwyer, F. M. The effectiveness of visual illustrations used to complement programed instruction. *The Journal of Psychology*, 1968, *70*, 157-162.

Dwyer, F. M. The relative effectiveness of varied visual illustrations in complementing programed instruction. *The Journal of Experimental Education*, 1967, *36*, 34-42.

Dwyer, F. M. The effectiveness of selected visual illustrations in teaching science concepts to college freshmen. *The Journal of Educational Research*, 1968, *61*, 343-347.

Dwyer, F. M. When visuals are not the message. *Educational Broadcasting Review*, 1968, *2*, 38-43.

Dwyer, F. M. The effect of varying the amount of realistic detail in visual illustrations designed to complement programed instruction. *Programed Learning and Educational Technology*, 1969, *6*, 147-153.

Dwyer, F. M. Effect of questions on visual learning. *Perceptual and Motor Skills*, 1970, *30*, 51-54.

Dwyer, F. M. The effect of image size on visual learning. *The Journal of Experimental Education*, 1970, *39*, 36-41.

- Contains data found in:

  Dwyer, F. M. *An evaluation of image size as an instructional variable on television*. Unpublished Research Report, University Park, The Pennsylvania State University, University Division of Instructional Services, 1969.

Dwyer, F. M. Visual learning: An analysis by sex and grade level. University Park, The Pennsylvania State University, University Division of Instructional Services, 1970. (ERIC Document Reproduction Service No. ED 041 478)

- Contains data found in:

  Dwyer, F. M. A study of the relative effectiveness of varied visual illustrations. USOE Final Report, Project No. 6-8840, Grant No. OEG-1-7--68840-0290. University Park, The Pennsylvania State University, University Division of Instructional Services, 1967. (ERIC Document Reproduction Service No. ED 020 658)

  Dwyer, F. M. An experiment in visual learning at the eleventh-grade level. The Journal of Experimental Education, 1968, 37, 1-5.

  Dwyer, F. M. Effect of visual stimuli on varied learning objectives. Perceptual and Motor Skills, 1968, 27, 1067-1070.

  Dwyer, F. M. An experiment in visual communication. Journal of Research in Science Teaching, 1969, 6, 185-195.

  Dwyer, F. M. The effect of stimulus variability on immediate and delayed retention. The Journal of Experimental Education, 1969, 38, 30-37.

Dwyer, F. M. An experimental evaluation of the instructional effectiveness of black and white and colored illustrations. Didakta Medica, 1971, 3&4, 96-101.

Dwyer, F. M. Color as an instructional variable. AV Communication Review, 1971, 19, 399-416.

Dwyer, F. M. The effect of overt responses in improving visually programed science instruction. Journal of Research in Science Teaching, 1972, 9, 47-55.

Dwyer, F. M. On visualized instruction effect of students' entering behavior. The Journal of Experimental Education, 1975, 43, 78-83.

- Correctly entitled:

  Effect of students' entering behavior on visualized instruction.

Haynie, W. J., III. The instructional effectiveness of realism and enhancement of illustrations as related to visual continuum theories (Doctoral dissertation, The Pennsylvania State University, 1978). Dissertation Abstracts International, 1979, 39, 4666A-4667A. (University Microfilms No. 7902608)

Joseph, J. H. The instructional effectiveness of integrating abstract and realistic visualizations. The Pennsylvania State University, 1978. Dissertation Abstracts International, 1979, 39, 5907A. (University Microfilms No. 7909090)

TITLE: Learner Interest and Instructional Design:
A Conceptual Model

AUTHOR: Bernard J. Dodge

LEARNER INTEREST AND INSTRUCTIONAL DESIGN:

A CONCEPTUAL MODEL

Bernard J. Dodge

Syracuse University

INTRODUCTION

In 1968, George Leonard wrote a provocative book titled Education and Ecstasy. A chapter in the book described a visit to a typical school in the year 2001, and needless to say, it was very different from today's schools. While some may write the chapter off as an amalgam of all the hopes, fads and follies of the late Sixties, there are ideas in those pages that still seem exciting today.

One image from the book was that of a child seated at a console engaging in dialog with a computer. Their conversation was a combination of a spelling lesson and a poetry workshop, and the computer responded instantly to the child with moving graphics and sound. At times, the video display spilled over into the displays of the other children in the room, producing unpredictable connections between different lessons. It was a sort of individualized Sesame Street segment, a blend of structure and surprise. The children were learning and they were totally involved.

In most schools today, moments of high learner interest are not as common as they should be. Those of us working to improve education might consider Leonard's vision of the future as an ideal to be aimed for: instruction which is effective, involving, and enjoyable. Can we provide such instruction now? I would suggest that we know much more about the cognitive elements of instruction than about involvement and enjoyment. Educational research based on cognitive psychology has provided principles for structuring and sequencing instruction for optimal learning but interest and motivation have either been assumed or neglected.

Sometime between now and 2001, we will need to learn a lot more about what makes things interesting. One way to begin is by studying the experience of being interested. What does instruction that is interesting and appealing feel like to the learner? The purpose of this paper is to review the literature on interest and emotion briefly, and to describe a conceptual model of learner interest in terms of its emotional components.

THE STUDY OF EMOTION

For much of this century, psychologists tended to avoid the empirical study of emotion. There were three reasons for this avoidance: 1) Behavioral scientists tended to view emotion as a unitary, global concept, which made operationalization difficult. 2) S-R drive-reduction principles dominated psychology. 3) There was no adequate theory dealing with separate and distinct emotions, each definable as a construct that could be studied by specified and repeatable operations. As a result, the realm of emotion remained a relatively unexplored territory (Izard, 1971).

When emotion was discussed within theories of motivation and behavior, it was often regarded as unidimensional. Hedonic theories of motivation tended to view emotion along a single continuum of pleasantness-unpleasantness (e.g., McClelland, Atkinson, Clark, and Lowell, 1953). Activation theorists redefined emotion as arousal, varying along a sleep-tension dimension. One even advocated abandoning the term "emotion" altogether (Duffy, 1962).

One aspect of emotion that lent itself to scientific study was the area of facial expressions. Typical experiments involved the rating of photographs of an actor displaying a range of emotions. Pairs of photographs were rated for their degree of similarity, and statistical analysis revealed the underlying dimensions of variation. In all studies, two dimensions appeared: Pleasant-Unpleasant, and Sleep-Tension (Schlosberg, 1954; Gladstones, 1962). A third dimension sometimes appeared in such studies, but it was usually weak and difficult to interpret. Abelson and Sermat (1962) concluded that a 2-dimensional model adequately accounted for differences in facial expression.

In contrast to studies of facial expression, research on verbal reports of emotion has often shown a three-dimensional structure. Izard (1972), for example, gave subjects the names of the eight fundamental emotions in his typology and asked them to recall a situation in their lives in which each emotion was strongly experienced. The eight emotions were: fear, shyness, interest, distress, anger, guilt, joy, and surprise. For each situation, The subjects also filled out a rating scale which asked them how active, deliberate, tense, impulsive, controlled, self-assured, extraverted, and pleasant they felt.

Analysis of the ratings showed that the Pleasantness, Tension, and Self-assurance dimensions were the best combination to distinguish the eight emotional situations. Joy, for instance, was characterized as being high in Pleasure and Self-assurance, and low in Tension. Izard concluded that the three dimensions of Pleasure, Tension, and Self-assurance represent the underlying structure of subjective experience of which emotion is one aspect.

In another attempt to uncover the dimensions of emotion, Bush (1973) had subjects rate pairs of emotional adjectives (e.g., sleepy, outraged, delighted) on a 10-point similarity scale. The ratings were analyzed by multidimensional scaling analysis. Three dimensions emerged: the first two were Pleasantness-Unpleasantness and Level of Activation. These are similar, if not identical to, the Evaluation and Activity dimensions found in semantic differential research, (Osgood, Suci, & Tannenbaum, 1957) and are also the factors found in studies of facial expression.

Bush labelled the third factor found in his study "Aggression", though he noted that the scale was not easily interpreted. At one end were adjectives like "outraged" and "delighted", while at the other were "sympathetic", "needed" and "desperate". He concluded that this dimension was closely related to the Potency scale of the semantic differential and, more specifically, seemed to refer to interpersonal potency.

Additional support for a three-factor model of emotion comes from work by Mehrabian and Russell in the field of environmental psychology (1974). Based on previous research, they postulated that the emotional response to an environment can be described along the dimensions of Pleasure, Arousal, and Dominance, in parallel to Evaluation, Activity, and Potency (Osgood, Suci, & Tannenbaum, 1957). They constructed an 18-item measure based on these factors and used it both as a measure of personality and as a state measure of emotional response. The measure was found to relate as they predicted with measures of anxiety (high Arousal, low Pleasure and Dominance), sensitivity to rejection (low Dominance), and several other measures. The state emotional response scale was used to measure reactions to a number of environmental situations, and the three dimensions of emotion were significant predictors of various approach and avoidance behaviors (Mehrabian & Russell, 1974).

A later study (Russell & Mehrabian, 1977) used the same scale to rate adjectives which depicted a full spectrum of emotions. A total of 151 terms were used, and each subject rated 10 to 20 of them. Again, the Pleasure, Arousal, and Dominance scales showed high reliability (.97, .89, and .87) and all three scales were necessary to distinguish among the emotional adjectives.

To summarize, two dimensions --Pleasure and Arousal-- have been shown to underlie a wide range of emotional outcomes. These two dimensions are seen as closely related to the dimensions of Evaluation and Activity which consistently appear in studies using the semantic differential technique. Several studies also provide evidence for a third dimension of emotion, one which is related to potency. These studies are summarized in Table 1.

STUDY	STIMULI	DIMENSIONS
Schlosberg, 1954	Facial expressions	Pleasantness-Unpleasantness Sleep-Tension Attention-Rejection
Gladstones, 1962	Facial expressions	Pleasantness-Unpleasantness Sleep-Tension Expressionless-Mobile
Abelson & Sermat, 1962	Facial expressions	Pleasantness-Unpleasantness Sleep-Tension
Izard, 1972	Recalled emotional situations	Pleasantness Tension Self-assurance
Bush, 1973	Emotional adjectives	Pleasantness-Unpleasantness Level of Activation Agression
Mehrabian & Russell, 1974	Descriptions of environments	Pleasure Arousal Dominance
Russell & Mehrabian, 1977	Emotional adjectives	Pleasure Arousal Dominance

TABLE 1: RESEARCH ON DIMENSIONS OF EMOTION

EMOTION AND INTEREST

The emotional response that accompanies a state of interest has rarely been studied. In fact, with the exception of work by Csikszentmihalyi (1975), there has been almost no attempt to examine in depth what interest and involvement feel like to an individual. This gap in the literature has been well articulated in a review by deCharms and Muir (1978):

> Intrinsic motivation presents a fascinating case of the state of the art. Theories and data abound. Are we making major advances in understanding motivation? Let us suggest that they are minor. We continually overlook our major source of knowledge --a personal, non-objective source which is at the heart of every minitheory but not acknowledged. Our methodologies fall short because they lead us into more and more detailed specification of external conditions for producing behavioral effects and ignore the critical variable, namely, the way the person experiences (not perceives) the conditions that we so elaborately contrive.(p. 107)

This is not to say that emotion has been totally ignored by those doing research on learner interest. Several theoreticians have called upon emotions as explanatory variables in their writings. Berlyne (1960), for example, said that curiosity comes as a result of a desire to maintain an optimal level of arousal. Things that are puzzling or incongruous cause a rise above the optimal level, and the individual studies and processes the stimulus to reduce uncertainty and bring arousal back to comfortable levels.

Theories of intrinsic motivation have also been based on affective concepts. White (1959) wrote of an innate need to feel effective, while Deci (1975) called it a need to feel competent and self-determining. Both of these needs were used to explain why we do things that have no extrinsic rewards attached, why we are interested in some activities for their own sake.

Another line of research on interests has involved the development and use of interest inventories: scales to measure preferences among sets of school subjects or vocations. The interest inventory can be viewed as a technological extension of hedonistic theories of motivation. That is, they assume implicitly that we are pleasure-seeking creatures who arrange our activities to maximize pleasure (Travers, 1978).

The major work to date which studied the actual experience of interest and involvement was described in a book by Csikszentmihalyi (1975). Csikszentmihalyi surveyed and interviewed chess players, rock climbers, surgeons and others to examine what made their activities self-rewarding. He discovered several qualities that seemed to characterize the occurance of intrinsic motivation, a state of mind that he called "flow".

Among these were a merging of action and awareness, the centering of attention, and the loss of self-consciousness. In emotional terms, the flow experience combined enjoyment, a feeling of mastery and control, and a level of arousal midway between boredom and anxiety.

Within this sample of inquiry in the area of interest, several different emotional variables have been cited as causes or correlates of interest. One might infer from this that interest is not a simple, pure emotion like happiness, for example, but a complex combination of feelings. If this is so, then perhaps the existing minitheories of curiosity and intrinsic motivation are accurate but incomplete, like the fabled blind men's description of the elephant. The tendency to regard interest as one-dimensional has held back progress toward understanding it, and prevented the building of a cumulative body of research.

A MODEL OF LEARNER INTEREST

If interest is multidimensonal, what are its dimensions? A logical analysis of the concept would suggest that the three factors underlying other emotions also make sense as dimensions of interest. The Pleasure-Displeasure dimension, for instance, is clearly relevant. To be interested is a pleasant feeling, and to be bored is not.

The Arousal dimension seems applicable to interest as well. Any definition of interest would have to include notions of a heightened awareness and attention, both of which are associated with moderate to high levels of arousal. Drowsiness and lack of interest, on the other hand, are states of low arousal. As already noted, arousal also figures prominently in previous research. The best articulated theory of curiosity, that of Berlyne (1960, 1963), is built around the concept of arousal. In addition, the "flow" state studied by Csikszentmihalyi (1975) was characterized by a facilitative level of arousal.

Thus a case can readily be made for Pleasure and Arousal as factors underlying learner interest. But what about the third dimension, one that is related to the Potency (strong-weak) dimension of semantic differential research? The question can best be addressed at a more abstract level: In an educational setting, what does it mean to feel stronger or weaker?

Learning adds to one's skills and abilities, and thus enables one to deal more effectively with the world. In a sense, an increase in competence is an increase in power. To feel more competent is to feel stronger, while incompetence and weakness are inextricably linked. Thus it would seem that a dimension of Competence - Incompetence feelings is an appropriate translation of potency within the context of learning.

The Competence Feeling dimension is tied to interest by some theoretical work already cited. Deci's cognitive evaluation theory proposes that activities which enhance a feeling of competence and self-determination are intrinsically motivating (1975). Such activities are done for their own sake, without the need for external compensation.

In an essay on interest and effort in education, Dewey (1913) made a distinction relevant to the Competence Feeling dimension. He said that there are two types of pleasure. One arises from contact with pleasurable stimuli such as bright colors and agreeable sounds. The second accompanies activity and is found wherever there is successful achievement and mastery occurring. These two types of pleasure are reflected in the present model as the Pleasure and Competence Feeling dimensions, respectively.

Dewey had few kind words for school activities which excite the senses but do not engage the learner in activity geared toward mastery. This same concern is echoed today in criticism about some educational media. In terms of the model, instruction which produces high levels of Arousal and Pleasure, but does not arouse Competence Feelings can be said to be more entertaining than educational. High levels of Pleasure, Arousal, and Competence Feelings, on the other hand, would indicate genuinely engrossing instruction.

Empirical evidence for the appropriateness of a competence feeling dimension comes from a study of what makes an educational television program interesting (MacLean et al, 1960). In a linkage analysis of viewer ratings of several program segments, factors of Evaluation (good-bad) and Activity (fast-slow) emerged which are closely linked to the Pleasure and Arousal dimensions discussed above. In addition, a third factor appeared which had to do with how well the program was understood. The researchers named this factor Simplicity, but it is clear from the items which loaded on the factor that it could as easily been interpreted as a dimension of Competence Feelings.

Thus far, we have described learner interest as having underlying dimensions of Pleasure, Arousal, and Competence Feelings. There is one more dimension yet to be described, one which also has to do with potency.

Strength and weakness in an educational context can also be conceptualized in another way. One is strong when one controls the content and mode of presentation of what is being learned. Weakness is having no such control. This second type of potency dimension is linked to learner interest by the widely held assumption that learner control enhances motivation. This assumption is intrinsic to the open school movement, and there is some empirical support for its validity (for example, Myrow, 1979). This feeling of being in charge of one's learning is closely akin to the Pawn-Origin dimension described by deCharms (1968, 1976). To use Deci's (1975) terminology, this dimension might be referred to as one of Self-determination Feelings.

To summarize the discussion to this point, a four-factor model of learner interest has been proposed. The rationale of the model is based on research showing a three-factor structure of emotion, and on a logical analysis of the concept of learner interest. The four factors are related to the Evaluation, Activity, and Potency dimensions of semantic differential research (Osgood, Suci, Tannenbaum, 1957) as follows:

SEMANTIC DIFFERENTIAL DIMENSIONS	LEARNER INTEREST DIMENSIONS
Evaluation	Pleasure
Activity	Arousal
Potency	Competence Feelings Self-Determination Feelings

USES OF THE MODEL

This model may be useful both as a conceptual tool and as a guide toward the solution of instructional problems. At the conceptual level, the model helps to bring diverse theories and approaches together within one framework. This provides a more holistic view of interest, affect and motivation and makes it easier to compare theories or to combine different theoretical perspectives.

The model also enables one to make finer distinctions than is possible with a single dimension ranging from boredom to high interest. The four factors can economically portray a wide range of affective/motivational responses to instruction. For example, one form of boredom might be represented by a combination of negative pleasure and low arousal. A closely related state would be drowsiness, which is mildly pleasant and low in arousal. The combination of high pleasure, moderate arousal and neutral competence and self-determination feelings might constitute a sort of passive fascination. Perhaps the optimum response for designers to strive for would be what Csikszentmihalyi (1975) calls "flow", a state of total involvement consisting of moderate arousal and high pleasure, competence, and self-determination feelings.

This ability to make fine distinctions among various types of boredom and interest also suggests uses for the model in solving instructional problems. Evaluation instruments could easily be constructed to measure each of the four dimensions, and could be used in the formative evaluation of instructional materials and presentations. A semantic differential format would be appropriate, with several scales for each dimension. Such an instrument would contain items such as the following:

While reading the textbook, I felt...

happy :...:...:...:...:...:...:...: sad
calm :...:...:...:...:...:...:...: excited
competent :...:...:...:...:...:...:...: incompetent
free :...:...:...:...:...:...:...: constrained

Using evaluation tools based on these four factors would enable more precise diagnosis of motivational deficiencies in instruction. A low level of competence feelings, for example, would indicate that the instruction simply doesn't teach well. Or, more interestingly, it might indicate that competence has crept up on the learners so gradually that they don't realize how much they have learned. In such a case, the remedy might be to add a challenging practice exercise that calls upon all of the newly acquired knowledge and skill.

While texts, audiovisual media, or live presentations can be evaluated this way, these four factors seem especially appropriate for use with educational games and simulations. These have a dual nature: they are supposed to be educational and they are supposed to be fun. Educational outcomes can be gauged by conventional measures of competence, and the affective counterpart of learning can be measured by a Competence Feeling scale. The fun-ness of a game should be directly related to the Pleasure and Arousal it evokes. The degree to which players feel self-determining may also be an important predictor of the overall success of a game.

Another possible use of the model would be in the design of responsive educational media. Presently, CAI and interactive videodisc programs respond primarily to the cognitive needs of the learner, providing more examples or practice when called for. It isn't difficult to imagine a more fully responsive program which takes the learner's emotional state into account and adjusts the instructional presentation when interest flags. The learner might indicate interest by the scale already described, or perhaps by physiological means of input (see Clynes, 1977; Knirk & Spindell, 1975). In any case, much research is needed before interest-enhancing adjustments can be prescribed with much certainty.

RESEARCHABLE QUESTIONS

A good conceptual model does two things: it organizes what is known and helps us formulate questions about the unknown. The model described in this paper provides an organizing framework for several distinct theories and conceptualizations of interest. It also suggests a number of questions in two general categories: 1) How do various instructional design techniques affect the emotional dimensions of learner interest? 2) How do the emotional dimensions relate to behavior? Discussion of a few representative questions in each category follows.

What is the effect on emotion of anecdotes and other human interest content? Flesch (1948) devised a widely used formula to measure the human interest level of text. The formula is based on counts of personal words (nouns and pronouns of natural gender) and personal sentences (quotes, questions, commands, exclamations, requests, and other sentences directly addressing the reader). Arbitrary as this may seem, this Human Interest score was highly correlated (rho = .83) with student ratings of interestingness in two separate studies (Croll & Moskaluk, 1977; Gillen et al, 1977). McConnell (1978) attributes much of the success of his best selling psychology text to his use of anecdotes, which also give the text high scores on the Flesch measure.

What sort of interest is evoked by using anecdotes to make a text more personal? If the anecdotes entertain but do not instruct, then it would seem that Pleasure and Arousal are involved. If the anecdotes aid learning by making ideas more concrete, then perhaps Competence Feelings are also raised, in addition to Pleasure and Arousal. This distinction is important for the design of instruction and merits further research.

What is the effect of varying the presentation format? The need for variety in presentation to maintain interest is well established in the conventional wisdom among teachers. Within a given medium of instruction, it is possible to present information in many different ways: tables, diagrams, question and answer interviews, anecdotes, metaphors, drills, and the usual expository prose. Recent research shows that different types of reading material engage the left and right hemispheres in different ways. Shifting the format from one type to another may have affective consequences. Berlyne's theory of epistemic curiosity (1960) suggests that each format change would cause a momentary rise in arousal as the learner gets oriented to the new format.

This raises several interesting questions. To maintain optimal arousal within a lesson, how often should the presentation format be changed? How does this rate interact with learner characteristics? Which pairs of formats result in the greatest arousal increments? Does allowing the learner to choose the presentation format significantly increase feelings of self-determination?

How do the emotional dimensions of learner interest relate to behavior? While interest during instruction is a desirable goal in itself, it is also important as the means to several ends. One such end is improved performance. Some studies support the commonsense notion that students learn more from material they find interesting (e.g., Asher, Hyman, & Wigfield, 1978; Fass & Schumacher, 1978). Other research finds no clear relationship between interest and learning (Wood, 1974). The problem with research in the latter category, however, may be that interest was assumed to be unidimensional. Research using a multidimensional approach might shed more light on the relationship between interest and learning.

Another important behavior related to interest is continuing motivation. Continuing motivation is briefly defined as "the tendency to return to and continue working on tasks away from the instructional setting in which they were initially confronted. This return is presumably occasioned by a continuing interest in the task and not by external pressure of some kind" (Maehr, 1976). Continuing motivation can be seen as an ideal outcome of schooling, given the speed with which knowledge becomes outdated. It is also important because there is seldom, if ever, enough instructional time available to convey everything worth knowing about a subject. When motivated to do so, students can quickly augment their education by pursuing a subject on their own time.

Is the tendency to continue learning about a subject related to the emotional response that accompanied the initial learning situation? In terms of the present model, continuing motivation might be predicted best by the Competence and Self-Determination Feelings evoked during instruction. Pleasure and Arousal, in contrast, may be more closely related to behaviors which demonstrate interest during the instructional period, and be only weakly related to a continuing interest in the material.

CONCLUSION

As the preceding sample of questions indicates, there is much yet to be learned about interest in education. In time we should be able to design instruction that can be relied on to interest a given audience, but for now our designs are based on intuition and luck. The new media of microcomputers and interactive videodisc present us with the opportunity to teach and fascinate at the same time. In order to realize the full potential of these media, we need to be clear about what learner interest is and what we can do to enhance it. The model described in this paper is offered as a small step in that direction.

REFERENCES

Abelson, R. P., & Sermat, V. Multidimensional scaling of facial expressions. Journal of Experimental Psychology, 1962, 63, 546-554.

Asher, S. R., Hymel, S., & Wigfield, A. Influence of topic interest on children's reading comprehension. Journal of Reading Behavior, 1978, 10, 35-47.

Berlyne, D. E. Conflict, arousal and curiosity. New York: McGraw-Hill, 1960.

Berlyne, D. E. Motivational problems raised by exploratory and epistemic behaviour. In S. Koch (Ed.), Psychology: A study of a science. New York: McGraw-Hill, 1963.

Bush, L. E. Individual differences multidimensional scaling of adjectives denoting feelings. Journal of Personality and Social Psychology, 1973, 25, 50-57.

Croll, W. & Moskaluk, S. Should Flesch counts count? Teaching of Psychology, 1977, 4(1), 48-49.

Csikszentmihalyi, M. Beyond boredom and anxiety. San Francisco: Jossey-Bass, 1975.

deCharms, R. Personal causation. New York: Academic Press, 1968.

deCharms, R. Enhancing motivation: Change in the classroom. New York: Irvington Publishers, 1976.

deCharms, R., & Muir, M. S. Motivation: Social approaches. Annual Review of Psychology, 1978, 29, 91-113.

Deci, E. L. Intrinsic motivation. New York: Plenum Press, 1975.

Dewey, J. Interest and effort in education. New York: Houghton Mifflin, 1913.

Duffy, E. Activation and behavior. New York: John Wiley, 1962.

Fass, W., & Schumacher, G. M. Effects of motivation, subject activity, and readability on the retention of prose materials. Journal of Educational Psychology, 1978, 70, 803-807.

Flesch, R. A new readability yardstick. Journal of Applied Psychology, 1948, 32, 221-233.

Gillen, B., Kendall, P. C., & Finch, A. J. Reading ease and human interest scores: A comparison of Flesch scores with subjective ratings. Teaching of Psychology, 1977, 4(1), 39-41.

Gladstones, W. H. A multidimensional study of facial expression of emotion. Australian Journal of Psychology, 1962, 14(2), 95-100.

Izard, C. E. The face of emotion. New York: Appleton Century Crofts, 1971.

Izard, C. E. Patterns of emotions: A new analysis of anxiety and depression. New York: Academic Press, 1972.

Knirk, F. G., & Spindell, W. A. Indirect (biofeedback) measurement in instructional technology. Educational Technology, 1975, 15(6), 33-35.

Leonard, G. B. Education and ecstasy. New York: Delacorte Press, 1968.

MacLean, M. S., Jr., Crane, E., & Kiel, D. F. What makes an ETV program interesting? In W. Schramm (Ed.) The impact of educational television. Urbana, Illinois: University of Illinois Press, 1960.

Maehr, M. L. Continuing motivation: An analysis of a seldom considered educational outcome. Review of Educational Research, 1976, 46, 443-462.

McClelland, D. C., Atkinson, J. W., Clark, R. A., & Lowell, E. L. The achievement motive. New York: Appleton Century Crofts, 1953.

McConnell, J. V. Confessions of a textbook writer. American Psychologist, 1978, 33, 159-169.

Mehrabian, A., & Russell, J. A. An approach to environmental psychology. Cambridge: MIT Press, 1974.

Myrow, D. L. Learner choice and task engagement. Journal of Experimental Education, 1979, 47, 200-207.

Ornstein, R., Herron, J., Johnstone, J.,& Swencionis, C. Differential right hemisphere involvement in two reading tasks. Psychophysiology, 1979, 16, 398-401.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. The measurement of meaning. Urbana, Illinois: University of Illinois Press, 1957.

Russell, J. A. & Mehrabian, A. Evidence for a three-factor theory of emotions. Journal of Research in Personality, 1977, 11, 273-294.

Schlosberg, H. S. Three dimensions of emotions. Psychological Review, 1954, 61, 81-88.

Travers, R. M. W. Children's interests. Kalamazoo, Michigan: Western Michigan University, 1978.

White, R. W. Motivation reconsidered: The concept of competence. Psychological Review, 1959, 66, 297-333.

Wood, J. W. The effect of interest upon reading performance as assessed by informal reading inventories. Unpublished dissertation. University of Oregon, 1974.

TITLE: The Organizing Function of Behavioral Objectives

AUTHORS: Wendy Dunn

Barry Bratton

THE ORGANIZING FUNCTION OF BEHAVIORAL OBJECTIVES

Wendy Dunn, Ph.D. Barry Bratton, Ph. D.

Introduction

In tracing the history of educational uses for behavioral objectives, it seems there have arisen two general rationales for writing objectives: (1) to aid the designer of instruction in clarifying the intent and structure of that instruction, and (2) to improve student performance by assisting study. As a group, instructional designers have been willing to endorse the utility of objectives for the effective design of instruction, and most theorists, such as Briggs and Gagne, purport their usefulness.

However, the assessment of the effect of objectives on student performance has traditionally been treated as an empirical question. It is this relationship between the student's use of objectives and his or her performance on a learning task which is the focus of this paper. If we are going to continue to advocate providing students with unit or course objectives as a part of their instruction, we should be able to clearly demonstrate that these objectives have a positive effect on that student's ability to learn the required content effectively.

Literature

Unfortunately, research to date has failed to show any clear relationship between the use of objectives and improved performance. (This literature is summarized in articles by Duchastel and Merrill (1973), Hartley and Davies (1976), Kibler and Bassett (1977), Kibler, Bassett, and Byers (1977), and Briggs (1977).)

Early studies, which optimistically set out to document the expected differences in performance between groups having and groups not having objectives to guide their study provided results which can only be described as inconclusive.

Because these studies yielded mixed results, the rationale shifted to attempting to reveal other variables which may have been influencing the impact of the objectives, such as: the specificity, location, and form of the objective; the length, subject matter, complexity, organization, and type of learning required in the to-be-learned passage; the type of test items and their location and timing; and the type of subjects involved in the study according to their sex, socioeconomic status, ability level, and personality type. Again, results from these experiments were for the most part inconsistent.

It seems apparent that what is needed to unravel this question is NOT a proliferation of more studies of the same type, but rather a re-definition of the research question. Instead of asking ourselves "WHEN do objectives work?", we need to be asking "HOW do objectives work to facilitate learning?" It is our opinion that this issue can be examined in the context of the cognitive strategies employed by the student in using objectives to guide learning.

Hypothesis

Psychologists have provided at least three identifiable cognitive functions that objectives may serve in facilitating learning. First, they may encourage self-evaluation. We know from studies of verbal learning that forced rehearsal will improve test performance over a simple re-reading of content. Objectives may act by encouraging a student to test and re-test himself over the to-be-learned content.

Second, specifying objectives may insure a consistency between the student's storage strategy and the format needed for recall. We know that cues provided to help the student recall learned information only work when the student has learned or stored the information according to those specific cues. If test items are written to correspond directly to objectives, then consistency between storage strategy and retrieval strategy is insured, thus facilitating recall.

Finally, objectives may serve an organizing function along the lines of David Ausubel's notions of advance organizers. Objectives may function in a similar fashion to advance organizers and create a "blueprint" or structure into which subsequent material may be incorporated. Thus, when objectives are provided, information storage is more effective than when there is no apparent storage strategy.

The present study was designed to examine this third hypothesis: Do objectives serve an organizing function for to-be-learned content by creating an organizational structure into which subsequent information can be incorporated?

Rationale and Materials

The following rationale was applied to test this organizing hypothesis: If objectives do provide a structure for interpreting and organizing the to-be-learned information, they should improve learning most when the text content itself is NOT well-organized. (If the materials are well-organized, the objectives would be redundant and their effect would be minimal.) Therefore, if objectives are used with content which is presented in both an organized and an unorganized state, they should facilitate the learning of the unorganized content over that of the organized material.

Consequently, a 10-page text-type passage was written so that in one condition it was Relationally Organized (the relationships between the facts presented were clearly explained) and in another condition it was Factually Organized (the pieces of factual information were stated but no apparent relationships between them were sepcified).

Furthermore, it was reasoned that the form of the objective would interact with the Organization Type as follows: Low level objectives cueing simple recall of factual information would be expected to operate equally well for both Relationally Organized and Factually Organized content since these objectives would not require any attempts at cognitive organization for the subject. Higher level objectives which required the subject to demonstrate a higher level of understanding of the organization of the content materials, however, should reveal a greater advantage when paired with Factually Organized than with Relationally Organized content. Results consistent with this hypothesis would be interpreted as supporting the notion that subjects use objectives to help them organize information. Two sets of objectives were written, one cueing knowledge of Factual information (The Factual Objectives) and the other referencing knowledge of the higher level of organization of the passage (the Relational Objectives).

One other variable was included in this study. It was assumed that the Organization Type by Objective Type interaction described above would be demonstrated only on test items which measured the subjects' understanding of content organization and not on items testing only strict recall of facts. Consequently, test items were matched to both sets of objectives and were written to measure both Relational and Factual knowledge. The Organization Type interaction was predicted to occur only on the test items measuring recall of Organizational knowledge.

Method

This rationale indicated the use of a 2 x 2 x 2 factorial design with variables being Passage Organization (Factual or Relational), Objective Type (Factual or Relational) and Test Item Type (Factual and Relational). The major predicted result, which is shown graphically in Figure 1, was a three-way interaction in which Objectives cueing Relationally Organized knowledge would provide better recall for Factually Organized than Relationally Organized passages on Items testing knowledge of the passage's organization.

Forty-eight subjects received a passage that was either Relationally Organized or Factually Organized and a set of behavioral objectives which cued either Factual knowledge or Relational knowledge. All subjects were given a sixty-four item multiple-choice post-test composed of items testing both Factual and Relational knowledge. Each subject also completed a nine-item Likert-type questionnaire assessing his/her perception of the utility of the objectives and the difficulty of content materials and instructions in order to identify any problems in the interpretation of materials or procedures.

A three-factor analysis of variance with repeated measures was used to reveal significant effects on posttest performance. Two-way analyses of variance were carried out on subject responses to each of the nine questionnaire items.

Results

The predicted Organization Type by Objectives Type by Item Type interaction for posttest scores proved significant at $p \leq .025$, however, the variable interacted in an unpredicted pattern. As can be seen by examining the Relational Test Item condition in Figure 2, rather than assisting recall for Factually Organized passages over Relationally Organized passages, Relational Objectives had just the opposite effect. Factual Objectives aided recall for Factually Organized passages; Relational Objectives facilitated recall for Relationally Organized content.

Discussion

These results were interpreted as lending no support for the hypothesized organizing function of objectives. They were instead viewed as consistent with a cueing specificity hypothesis as follows: Apparently, subjects in this experiment used the objectives to sort the to-be-learned content from other content so that they could maximize their test performance on information that they thought would be tested. This interpretation is made even more clear by re-drawing the triple-order interaction as shown in Figure 3. For well-organized content (the Relationally Organized passage),if the student is going to be required to know factual information, he will learn it best if given Factual Objectives. If he needs to learn about the Organization of the content, he will perform best when given objectives written to cue Organizational or Relational knowledge.

In other words, when confronted with typical text-type passages, these subjects studied the objective-referenced content and ignored the rest of the information presented.

Conclusions

The implications from this research appear to be two-fold. First, for the instructional designer, these results indicate that students do use objectives to guide their study, but they may learn the objective-referenced information to the exclusion of that content not specifically keyed by objectives. Consequently, when the exact outcomes of instruction can be enumerated, providing the student with objectives helps that student focus on what he or she needs to learn and thus facilitates performance. Since the student appears to be using objectives to guide his study and storage, the objectives should specify as clearly as possible exactly what the student should know and be able to do. However, when all the goals of instruction cannot be specified in the form of objectives, as is often the case, including only a "sample" of the objectives may cause the student to perform less well overall on the unit since that student may be directing his or her study toward only that part of the information keyed to objectives.

Second, this study was an attempt to look beyond simple classroom variables and examine underlying cognitive strategies which may be influencing scholastic performance. It is our opinion that as educational researchers, we need to be attempting to integrate other bodies of knowledge into the formulation of our theories and research questions. We believe that fruitful results may come from examining the conceptual problems underlying classroom variables. This study, for example, attempted to integrate research describing the processes of learning, memory, and cognition. Other research effort might focus upon theories in human development (e.g. Do learning strategies as they relate to the use of objectives change with the subject's age?); motivation (e.g. Does the motivation of the student impact the utility of objectives? or Do objectives themselves motivate student study?) ; or other pertinent subject areas. By examining instructional variables in the context of these and other orientations,we may gain a greater clarity and depth of understanding about the teaching-learning process.

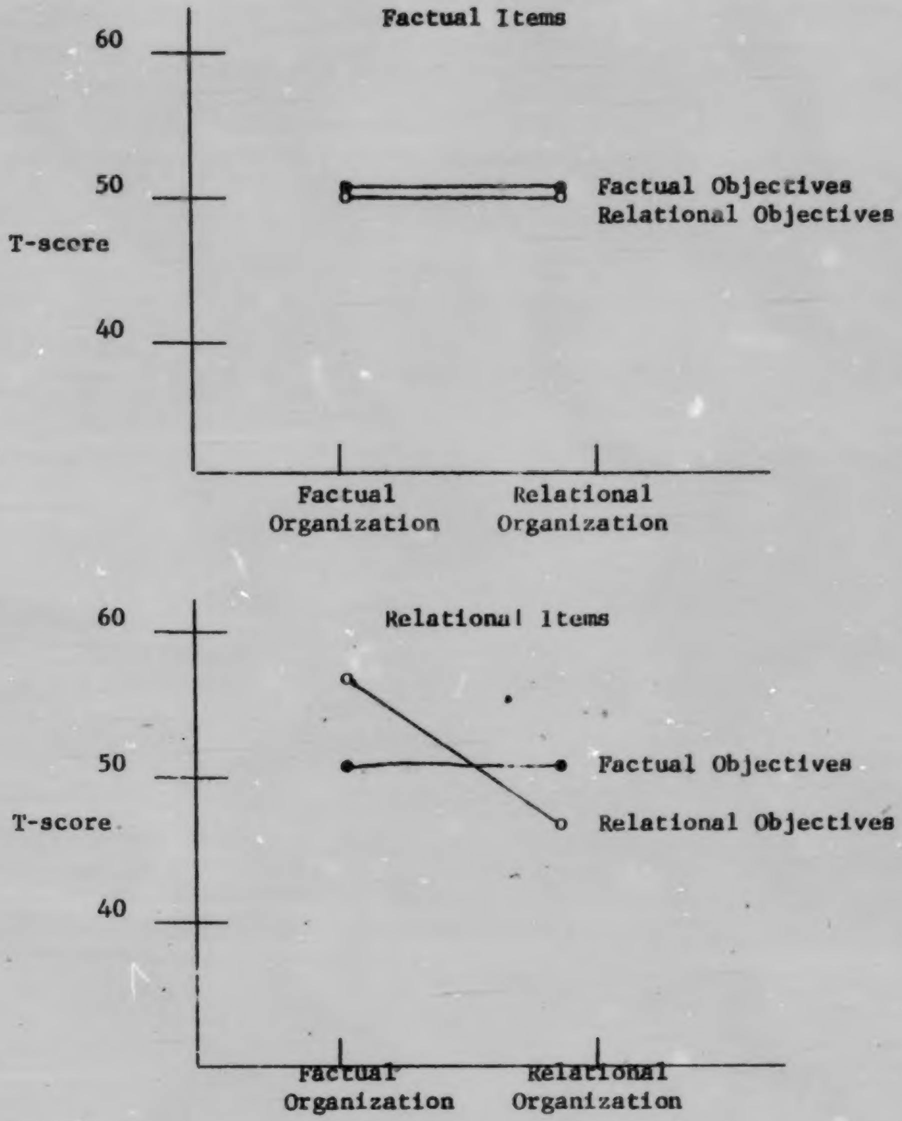


Figure 1

Hypothesized Organization Type by Objective Type by Item Type Interaction

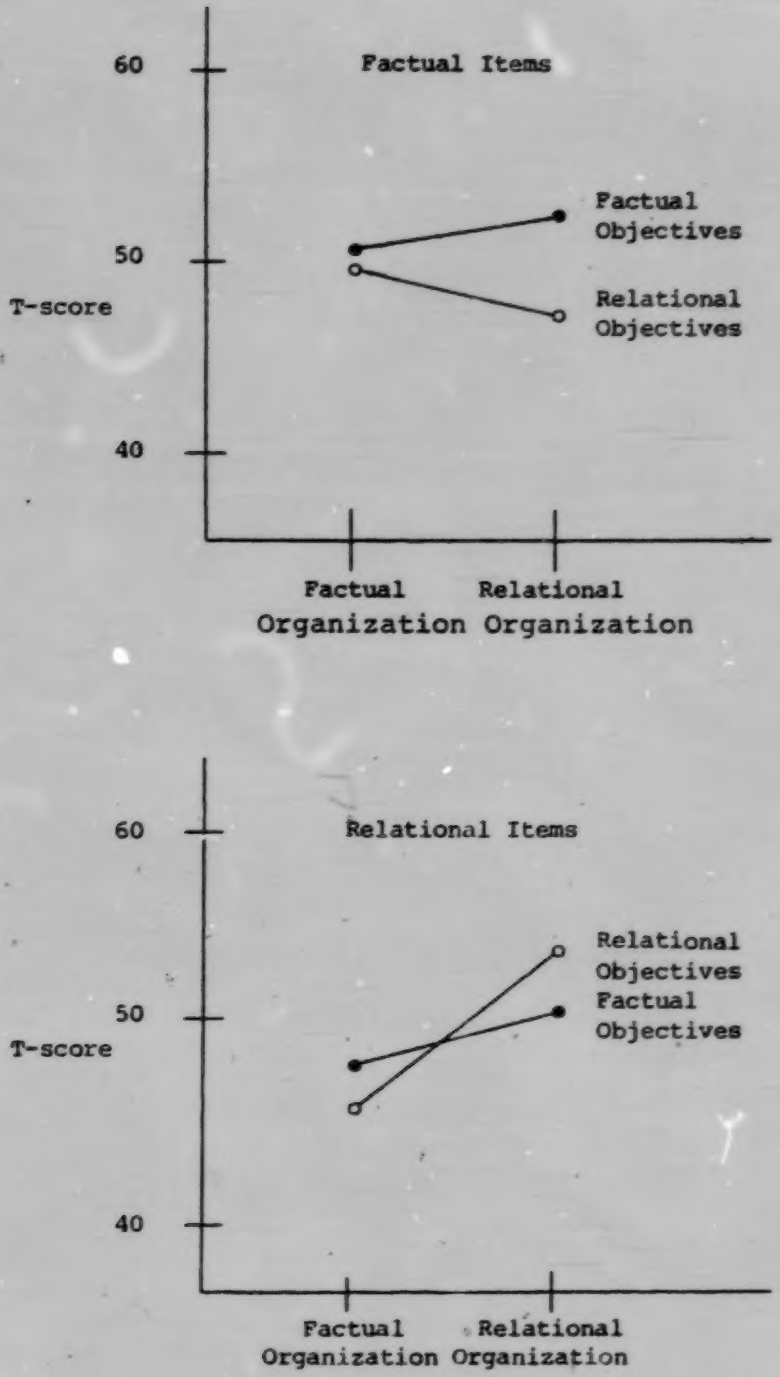


Figure 2

Organization Type by Objective Type by Item Type Interaction for Subjects' Transformed Performance Scores

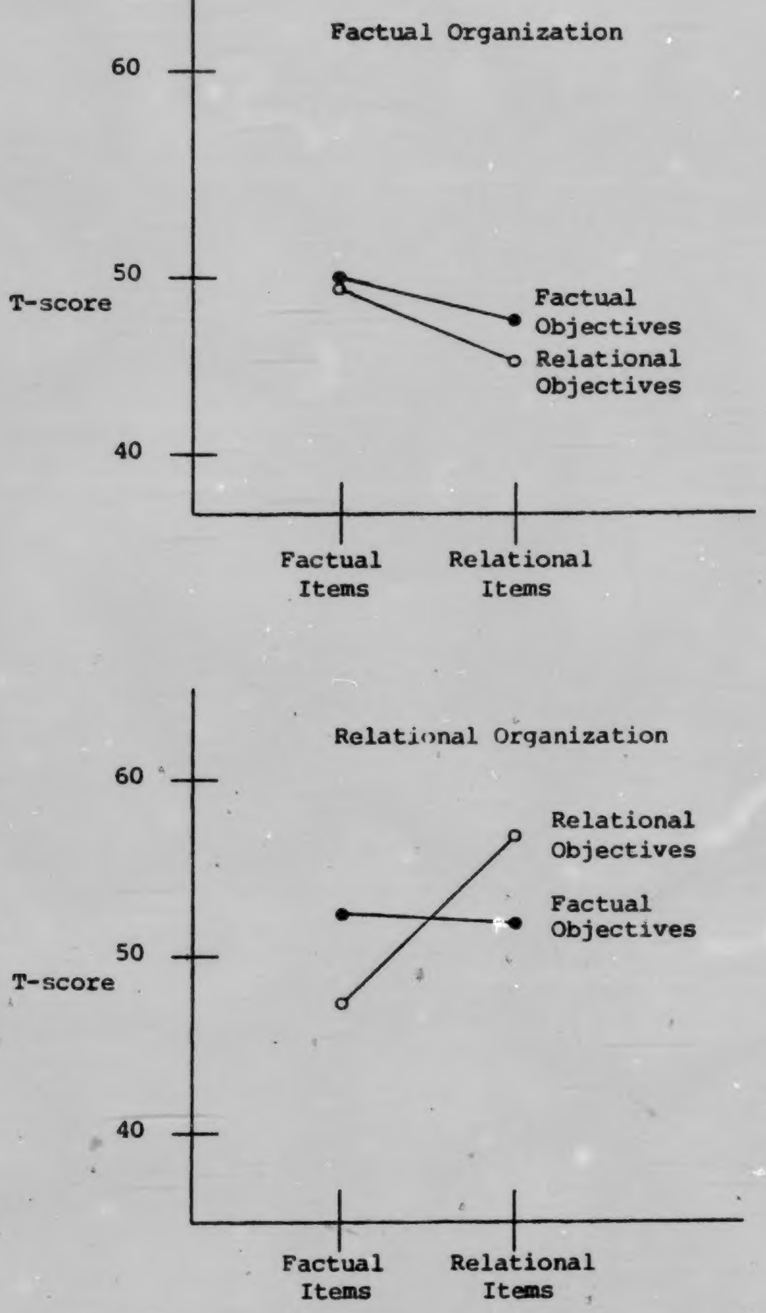


Figure 3

Organization Type by Objective Type by
Item Type Interaction for Subjects'
Transformed Performance Scores

TITLE: Attention to Instructional Media: What Are the Relevant Media Techniques and Learner Characteristics?

AUTHORS: Malcolm Fleming

W. Howard Levie

James McLeskey

Attention to Instructional Media:

What are the Relevant Media Techniques and Learner Characteristics?

Co-Investigators

Malcolm Fleming, Instructional Systems Technology

W. Howard Levie, Instructional Systems Technology

James McLeskey, Special Education

Indiana University

Bloomington, Indiana

Presenter

Malcolm Fleming

Paper presented at the annual meeting of the Association for Educational Communications and Technology. Denver: April, 1980.

* Attention to Instructional Media:

What are the Relevant Media Techniques and Learner Characteristics?

Visual attention has long been of central interest to the makers and users of instructional media (Ball and Byrnes, 1960; Miller, 1957; Fleming and Levie, 1978) for they have employed numerous techniques, e.g., closeups, underlinings, color cues, etc., in an attempt to make sure their audience notices the important ideas they are presenting. We found that visual attention is also of interest to the Special Education field. According to Crosby and Blatt (1968), "--professional opinion, derived from educational and clinical experience, has long identified impairments of attention as a general trait of the mentally retarded--" and further, "--at least four theorists (Zeaman and House, 1966; O'Connor and Hermelin, 1963; Denny, 1966; Luria, 1963) have posited specific attentional deficits in an attempt to account for certain learning impairments evidenced by retardates as a group." (p 69). We began to wonder how effective our media techniques for attention-getting and directing would be for mildly handicapped children who have difficulty selectively attending to instructional stimuli? This question is particularly pertinent to the current attempt to educate such children in the least restrictive environment i.e. to mainstream them.

The problem this study addressed was: What media techniques influence the attention of mildly handicapped learners toward the relevant information and away from the irrelevant information in instructional media?

The media literature is replete with references to such techniques and includes some studies which find learners attending unpredictably to unintended information. For example, an early study (Neu, 1950) showed that

---

* This research was funded in part by a grant (USOE G 007804210) from the Bureau of Education for the Handicapped, Division of Media Services.

attention-gaining techniques employed in a how-to-do-it film actually detracted from effectiveness, i.e., drew attention to themselves and did not increase learning. A more analytical study using eye-movement data (Guba, and others, 1964) found that attention to a televised science demonstration was often focussed on the demonstrator's face (irrelevant) rather than on the science object (relevant) he was discussing.

Some of the media studies finding positive effects on learning are the following, together with the attentional techniques studied: Allen, Cooney, and Weintraub (1968) verbal directions; Gibson (1947) distortion or exaggeration of relevant cues; Lumsdaine, Sulzer and Kopstein (1961) pop-on labels, arrows; Trenchord and Crissy (1951) large size, upper left position, color; Wolf (1971) repetition factors, novelty and complexity.

Other sources list numerous specific techniques presumed or found to influence attention, e.g., Allen and Goldberg (1977) recommend that media producers provide verbal directions, present only critical cues, use visual emphasizers, use motion, use different media; May (1965) refers to color, visual pointers, "implosion techniques," cue familiarization including extreme closeups, subjective camera, inserted questions; Ball and Byrnes (1960) refer to verbal captioning and labelling, eye attractors such as color, brightness, movement, size, white space, shape.

An extensive program of research on retarded children (Zeaman, 1973; Zeaman and House, 1966) ascribes deficiencies in discrimination learning to attentional differences rather than learning process differences. They repeatedly found that stimulus novelty strongly influenced the attention of retarded children. The sudden introduction of novel cues was often accompanied by sudden solutions to discrimination problems.

In another study, Wilhelm and Lovaas (1976) trained both retarded and normal children to accurately distinguish between two pictures. Then they tested the childrens' recognition memory for the objects in the pictures. The normal subjects correctly recognized all three objects in the pictures while the mildly retarded recognized an average of 2.1 objects and the severely retarded only 1.6. Apparently the retarded children had selectively attended to only part of the pertinent information.

Hagen (1972) found a development trend in normal children for increased learning of the central information in pictures and decreased learning of incidental information. However,retarded children failed to make this distinction between central and incidental information.

Attentional processes have been more clearly implicated in retardate learning deficiencies where studies have included eye-movement data. For example, Boersma and Muir (1975) found retarded learners to be deficient in visual attention. Their eye fixation patterns indicated they did not select important cues in the pictorial displays. Similarly, Mackworth and Bruner (1970) found that retarded subjects were less likely to look at important areas in pictures than normal subjects.

The weight of the evidence in the preceding is that mildly handicapped children are deficient in their attentional processes, and that this deficit could place severe constraints on their ability to learn from instructional media unless compensated for by special media techniques for influencing attention. However our brief survey of selected videotapes, films, and filmstrips for handicapped learners revealed only spotty and infrequent use of attention influencing techniques.

Our investigation of this problem extended to five exploratory studies, parts of which I will briefly summarize here.

The project was interdisciplinary, the investigators besides myself including Dr. Howard Levie of the Audio-Visual Department and Dr. James McLeskey of Special Education. The several graduate assistants had had experience in one or the other area as well.

The independent variables of greatest interest were the attention-influencing techniques incorporated in media. Over a dozen were tested but primary emphasis was on arrows, contrast, verbal cuing, and motion.

Conceptually the techniques were divided into attention-getting and attention-directing techniques and into learned and unlearned cues. We hypothesized that the learned cues e.g. arrows, would be more effective with older children than younger. In contrast, the unlearned cues (those that appeal to basic attentional processes e.g. changes in brightness, color, or motion) would be equally effective across age groups.

Subjects were chosen to reveal any developmental trend. The sample included the entire EMR (educable mentally retarded) population of the three local middle schools and all of those in the two elementary schools with the largest number of EMR children.

Subjects were individually tested, and each served as his/her own control in a repeated measures design. Stimuli in either slide or motion picture form were rear projected onto a small screen 3 feet in front of the subject.

During stimulus presentation a record of the subject's eye movements was made. Following presentation, either a recognition or recall test was given. Thus the dependent variables were eye-fixation patterns and recognition or recall.

The eye-movement detection equipment was of the corneal reflection type, and the data were recorded on 16 mm film. The subject wore a kind of face mask which weighed about a pound and was fitted securely and comfortably to the head. It was aligned for each subject so that a spot of light directed to the side of the right cornea reflected into a prism system and through fibre optics to the camera. Because the eye ball is egg-shaped instead of round, the position of the reflected spot of light moves as the eye moves. This spot of light, called an eye marker, was superimposed over an image of the scene being viewed, and both were recorded on 16 mm film. (See Figure 1). The result was a film record of the scene with a superimposed white mark intermittently moving and stopping where the subject was looking at any moment. The camera ran at 8 frames/second and thus provided 8 data points a second as to where the subject's eyes were fixated.

An initial exploratory study investigated the effects of attention influencing devices added to instructional materials intended for EMR learners. Frames were selected from a couple of filmstrips to produce a 26-frame sound slide set in two versions composed of control slides (unchanged from the original filmstrips) and experimental slides (altered to include a dozen different attention-influencing devices). This sound slide set was presented individually to 22 EMR subjects divided between elementary and middle school levels. Eye-movement records were made followed by a recognition memory test for selected objects, both those that had been accentuated in the stimuli (target objects) and those that had not (incident objects). Distractors were from the same filmstrips but had not been previously shown. Overall recognition accuracy data were as follows:

	Target objects	Incidental objects
Experimental (accentuated)	94%	42%
Control (not accentuated)	82%	52%

As can be seen the experimental version increased recognition memory for target objects (82% to 94) and reduced memory for incidental objects (52% to 42).

Of the twelve accentuation devices in this preliminary study, those having the largest influence on memory were arrows and audio prompts.

The effect of the attention-influencing techniques on eye-movement patterns was considerable. For nine of the attention-influencing devices studied, the eye movements indicated a positive effect, i.e. accentuated objects were fixated more rapidly and for a longer time than where the same objects were not accentuated. These devices were color, brightness, contrast, sharpness of focus, reduction of irrelevant detail, close-ups, arrows, outlining, direct and indirect auditory cues. For example here is the effect of audio cues on the percent of time the subjects fixated on the accentuated object as compared to the same object without accentuation.

	No audio	Indirect cue (Object named)	Direct Cue (Told to look at object)
Experimental (accentuated)	15%	29%	33%
Control (not accentuated)	12%	12%	7%

Note that auditory verbal cues, both indirect and direct, about doubled looking time on the target object. However, printed verbal labels were not effective, for they were apparently not read by the retarded children in this initial study.

The more effective techniques from this study were examined further in follow up studies, together with one not initially studied: motion.

In one series of studies stimuli were nine slides each containing pictures of three familiar objects arranged in a triangle. See Figure 2. Pictures were line drawings with moderate detail. In one condition an arrow pointed to the target object, in another the target was high contrast (black lines on white ground) while the incidental objects were low contrast (grey lines on white), and in the control condition there was no accentuation.

The dependent variables were eye movements plus recognition memory in one study and name recall in another study. The picture recognition data favored the arrow condition while the name recall data favored the contrast condition particularly for elementary EMR children. The largest effects in the eye-movement data were attributable to spatial location, i.e. 40% of fixations being on the object located upper central in the frame as compared to 25% divided between the objects located lower left and right.

In one follow-up study with similar stimuli the independent variable was verbal instructions, i.e. Look at the ____. Compared were oral, print, oral plus print, and control conditions. Target objects were either lower left or lower right to control for the spatial location effect previously obtained. All the verbal accentuation techniques were highly and equally successful. Twice as many target objects were correctly recognized as compared to incidental objects. The eye-movement data also indicated strong differential attention to the target object where verbally cued, that is more rapid orientation to it and a longer fixation time on it. For example here is a comparison of the on-target fixation times (seconds).

	Elementary EMR	Middle School EMR	Middle School Normal
Print	2.14	1.92	1.78
Oral	2.10	2.25	2.04
Both	2.00	2.05	1.93
Neither	1.07	1.07	1.25

Verbal cueing of all three kinds about doubled the fixation time for both levels of EMR children and, importantly, neutralized the differences due to grade level or ability level as measured by both recognition and eye-movement data.

In the other follow up study, arrow and motion cues were tested. Stimuli consisted of twelve scenes each consisting of a group of eight line drawings of familiar objects. The drawings were sparcely detailed and were arranged in a consistent pattern around the edges of the frame. (See Figure 3).

The task was to find the animal in each scene. In four scenes an arrow accentuated the animal, in four others the animal moved slightly, and in the other four there was no accentuation.

The dependent variables were orientation time (measured by eye-movements) and recognition memory. To make the orientation-time measure more precise each scene was preceded by a blank scene having a blinking star at the edge. Subjects were to look at the star first, thus providing a consistent starting point in the subsequent search for the animal.

Results showed that the animals receiving the accentuating cues were correctly recognized more than those not receiving the cues. However the effect differed across groups, there being no reliable effect for elementary EMR subjects, a significant effect ($p < .02$) for middle-school EMR subjects and a borderline effect ($p < .07$) for the middle school normal subjects. Differences between treatments were in part masked by an overall ceiling effect in recognition memory.

Differences were more apparent in orientation times as indicated by the eye-movement data. Time was measured from the onset of the scene to the first eye fixation on the target animal. As can be seen in Figure 4, the motion condition was significantly more effective overall than the control (p = .0001), but there was no difference between the arrow and control conditions. The curves suggest an interaction, with the motion condition largely eliminating the difference between the EMR and normal children. However, statistical analysis failed to show this effect to be reliable.

Several tentative conclusions and recommendations for practice can be drawn from these studies:

1. Most attention-influencing techniques used in instructional audiovisual presentations can have an impact upon the behavior of retarded as well as normal learners. However, these techniques vary in their effectiveness, and may be marginal in some cases. We would speculate that the effectiveness of some techniques is substantially less that supposed by designers and producers of audiovisual materials.
2. Motion, an attention-getting cue, was shown to have a strong effect for both EMR and normal learners, making more rapid their finding of the target object and lengthening their attention to it.
3. Printed or spoken instructions to look at an object, attention-directing cues, made significant differences in both recognition memory and eye-movement patterns in favor of the target objects as compared to the incidental objects. This effect was uniform across all ages tested and eliminated the differences between retarded and normal children on the task.
4. In some circumstances, spatial location in the visual field can also have an important impact upon attention to an object, the upper central position in a frame being a dominant one.

5. The effectiveness of several other types of attention-influencing techniques e.g., arrows, and brightness contrast, was nil in some conditions and only modest in others.
6. There is some evidence that arrows may be less reliable for younger learners and more complex tasks, which is consistent with our prediction that arrows, being a learned or acquired technique, would be developmentally sensitive.
7. The most consistent effect of attention-influencing techniques was on eye-movements, causing learners to look more quickly and for a longer time at the critical information. While these differences were only a matter of seconds, the effect in fixed-pace media, e.g. motion picture or TV, might be important. Scenes in such media are sometimes short, so non-productive looking at irrelevant cues could often be costly, for there is no chance for a second look. This effect would be particularly serious for the young or EMR learner.

References

Allen, W. H., Cooney, S. M., and Weintraub, R. *Audio implementation of still and motion pictures.* USOE Final Report, Project No. 5-0741, Los Angeles: University of Southern California, 1968.

Allen, W. H. and Goldberg, K. E., *Designing instructional media for educable mentally retarded learners.* Columbus, Ohio: National Center on Educational Media and Materials for the Handicapped, 1977.

Ball, J. and Byrnes, F. C. (Eds.) *Research, principles, and practices in Visual Communication*, East Lansing: Michigan State University, 1960.

Boersma, F. J. and Muir, W. *Eye movements and information processing in mentally retarded children*, Rotterdam: University Press, 1975.

Fleming, M. L. and Levie, W. H. *Instructional Message Design: Principles from the Behavioral Sciences.* Englewood Cliffs, New Jersey: Educational Technology Publications, 1978.

Crosby, K. G. and Blatt, B. Attention and mental retardation. *Journal of Education*, 1968 (3), *150*, 67-81.

Denny, M. R. A theoretical analysis and its application to training the retarded. In N. R. Ellis (Ed) *International review of research in mental retardation*, Vol. 2, New York: Academic Press, 1966.

Gibson, J. J. (Ed.). *Motion picture testing and research.* Army Air Forces Aviation Psychology Program, Research Report #7. Washington, D.C.: Government Printing Office, 1947.

Guba, E., Wolf, W. DeGroot, S., Knemeyer, M., Van Atta, R., Light, L. Eye movements and TV viewing in children. *AV Communication Review*, 1964, *12* (4), 386-401.

Hagen, J. W. Strategies for remembering. In S. Farnham-Diggery (Ed.) *Information Processing in Children*, New York: Academic Press, 1972.

Lumsdaine, A. A., Sulzer, R. L. and Kopstein, F. F. The effects of animation cues and repetition of examples on learning from an instructional film. In A. A. Lumsdaine (Ed.) *Student response in programmed instruction.* Washington, D. C.: National Academy of Sciences, 1961.

Luria, A. R. *The mentally retarded child.* Oxford: Pergamon, 1963.

Mackworth, N. H., and Bruner, J. S. How adults and children search and recognize pictures. *Human Development*, 1970, *13*, 149-177.

May, M. A. *Enhancements and simplifications of motivational and stimulus variables in audiovisual instructional materials*, U. S. Office of Education Contract OE-5-16-006, ERIC #J03169, 1965 .

Miller, N. E. (Ed.) Graphic communications and the crisis in education, *Audio-Visual Communication Review*, 1957, *5* (3), 1-120.

Neu, D. M. *The effect of attention-gaining devices in film-mediated learning.* Technical Report SDC 269-7-9, Port Washington, New York: U. S. Naval Training Special Devices Center, 1950.

O'Connor, N. and Hermelin, B. *Speech and thought in severe subnormality.* New York: Pergamon, 1963.

Trenchard, K. I. and Crissy, W. J. E. Trends in the use of certain attention-getting devices in newsweekly advertising. *Journal of Applied Psychology*, 1951, *35*, 287-288.

Wilhelm, H. and Lovaas, O. I. Stimulus overselectivity: A common feature of autism and mental retardation. *American Journal of Mental Deficiency*, 1976, *81* (1), 26-31.

Wolf, W. Perception of visual displays. *Viewpoints*, 1971, *47* (4), 112-140.

Zeaman, D. One programmatic approach to retardation. In D. K. Routh (Ed.), *The experimental psychology of mental retardation.* Chicago: Aldine, 1973.

Zeaman, D. and House, B. J. The relation of IQ and learning. In R. M. Gagne (Ed.), *Learning and individual differences.* Columbus, Ohio: Charles E. Merrill Books, 1966.

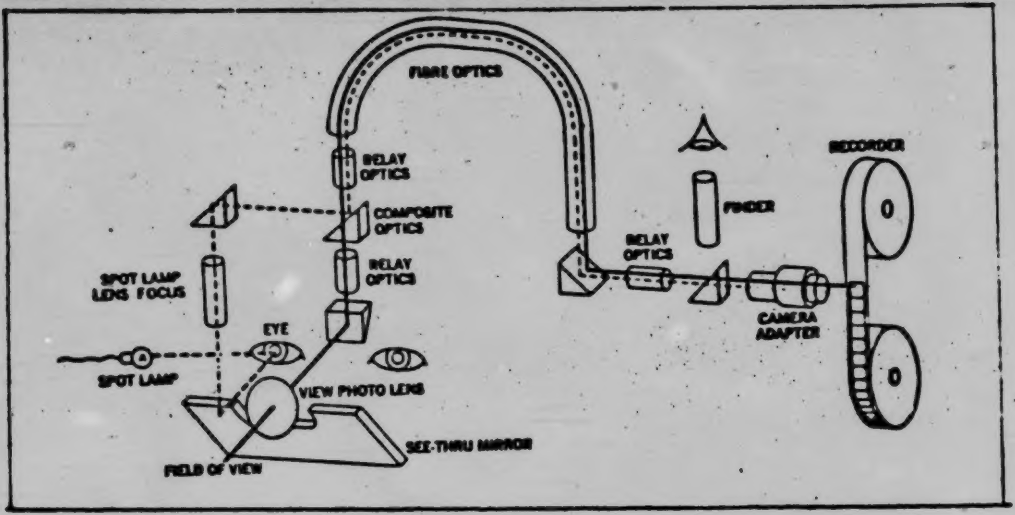

FIBRE OPTICS
RELAY OPTICS
COMPOSITE OPTICS
RELAY OPTICS
SPOT LAMP LENS FOCUS
EYE
SPOT LAMP
VIEW PHOTO LENS
SEE-THRU MIRROR
FIELD OF VIEW
FINDER
RELAY OPTICS
CAMERA ADAPTER
RECORDER

Fig. 1. Schematic of eye-movement detection and recording instrumentation.

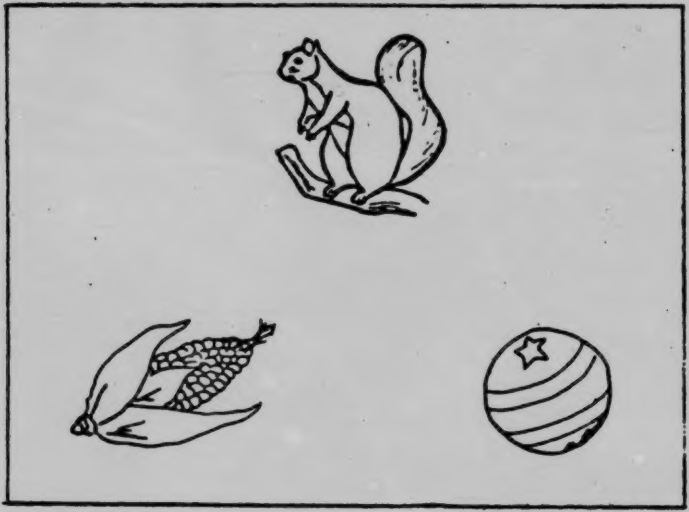


Fig. 2. Example of type of stimulus (control condition) used in studies of arrows, contrast, and verbal instructions as cues to influence visual attention.

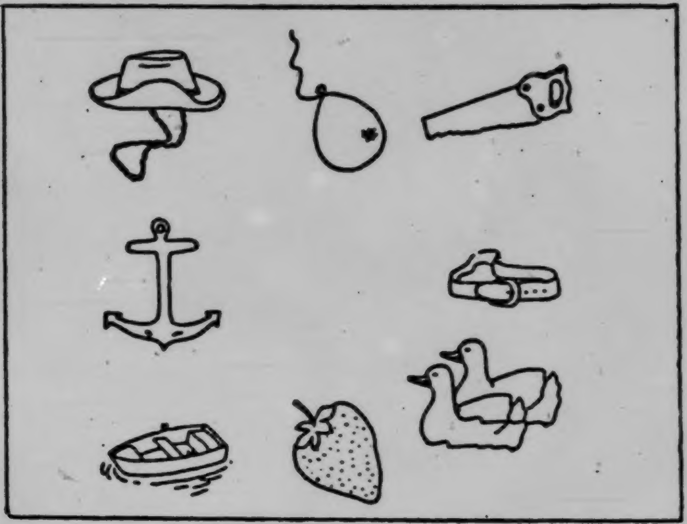


Fig. 3. Example of type of stimulus used in study of arrows and motion (implied in duck) as cues to influence visual attention.

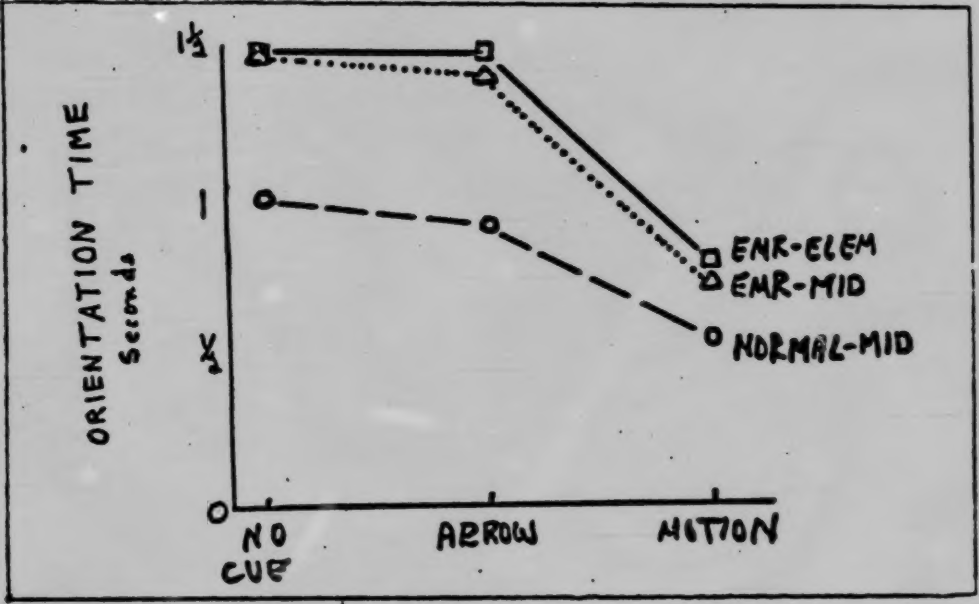


Fig. 4. Orientation times (seconds) to target object for three conditions and three groups: EMR Elementary, EMR Middle School, and Normal Middle School.

TITLE: Algorithmic Training for a Complex Perceptual-Motor Task

AUTHORS: Vernon Gerlach

Richard F. Schmid

Algorithmic Training for a Complex Perceptual-Motor Task

Objective

To determine the effect of algorithmic instruction on acquisition of perceptual-motor performance on an instrument flight task.

Perspective

Research has led to the formulation of prescriptions for algorithmizing cognitive pretraining (Gerlach and Brecke, 1973; Gerlach, Reiser, & Brecke, 1977; Gerlach and Schmid, 1977; Schmid and Gerlach, 1978). Trainees whose cognitive pretraining included algorithmic instruction based on precisely specified verbal rules outperformed other trainees when the dependent variable was the learning of a complex instrument flight maneuver. The research, however, did not yield data which could be used as a basis for generating the algorithms. The present research is the next step in that endeavor.

Methods

A standard set of rules, constructed according to methods discovered in earlier research (Brecke and Gerlach, 1972), were generated. The resulting set of rules was revised four times on the basis of feedback from subject matter experts (instructor pilots). This set of rules constituted the rule (R) level of instruction, the independent variable. The algorithm (A) level included only the presentation of the substance of these rules in an algorithmized form.

The two levels represented the basis for instructional materials administered during a cognitive pretraining phase prior to perceptual-motor training in a simulator. The mode of presentation for the first experiment approximated current USAF procedure as closely as possible. Amount of practice was held constant. For the second experiment, the rules or algorithms were embedded in instruction which was also varied in terms of practice. A low level of practice included one practice item per maneuver sequence, whereas the high level included three identical practice items.

There was a delay of five minutes between cognitive pretraining and simulator training. The simulator training phase consisted of a warm-up period in straight and level flight and six to eight trials separated by one minute intertrial intervals.

Data Source

Eleven USAF undergraduate pilot trainees' performance for the entire simulator training period was recorded on tape by means of an analog-to-digital converter and recorder. Observations were made at one-second intervals of five flight (i.e., aircraft) variables (airspeed, altitude, vertical velocity, pitch, and heading) and one control (i,e., student) variable (power or throttle position).

In the second experiment, 32 trainees' cognitive mastery of the instructional material was measured by means of a paper-and-pencil test administered immediately after pretraining. Subjects' attitudes were assessed on the basis of responses to a questionnaire administered following the simulator training period.

Results and Conclusions

The raw data for flight and control parameters were summarized by three methods. Comparisons using analysis of variance procedures were made on single variables as well as on composite performance scores. In addition to these statistical methods, graphic methods of data analysis were used.

The results of both experiments clearly demonstrated the superior instructional effectiveness of materials containing systematically developed algorithms. Both cognitive achievement after pretraining and perceptual-motor performance during simulation training were significantly higher for groups receiving systematically developed algorithms. Practice showed no significant main effect or interaction on either the cognitive or the perceptual-motor measures. The latter finding is explained by a ceiling effect: the low practice level permits subjects to attain maximum performance.

Another significant result was obtained from the responses to the questionnaire: subjects receiving systematically-generated algorithms displayed a more positive attitude towards the experiment, even under the duress of boring practice, than did those who received the rules.

Scientific Importance of the Study

The study indicates that systematically designed cognitive pretraining can facilitate the acquisition of a complex perceptual-motor task. It also offers empirical support for a specific paradigm for generating algorithms. The findings are heuristic with respect to future research on training for complex skills.

Vernon S. Gerlach
Arizona State University

Richard F. Schmid
Concordia University

Note to discussant: Because of the non-verbal nature of the stimuli and the responses in this study, the results of the study will be presented by means of slides and/or motion pictures at the convention.

TITLE: The Systematic Design of a Persuasive Communication for Changing Attitudes of Preservice Teachers Toward Science

AUTHORS: Barbara L. Grabowski

Paul W. Welliver

Robert L. Shrigley

THE SYSTEMATIC DESIGN OF A PERSUASIVE COMMUNICATION FOR CHANGING ATTITUDES OF PRESERVICE TEACHERS TOWARD SCIENCE

by

Barbara L. Grabowski

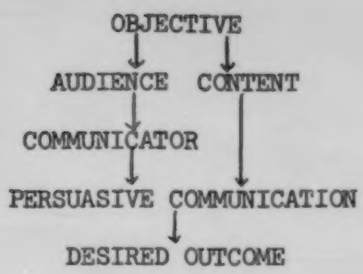
Paul W. Welliver

Robert L. Shrigley

Although attitudes have been investigated for over one hundred years, there is still much to be learned about the systematic design of instructional persuasive communications (Gabel, 1979). When the instructional development literature is searched for guidelines and research support for the systematic design of instruction in the affective domain, not much empirical evidence is found for the advice that is given. What is needed then is for attitude theory to be operationalized into an instructional design model and tested to be useable by educators and instructional developers.

The purpose of this investigation was threefold: (1) to test a persuasive communication that had been designed using Hovland's framework; (2) to question the relevance of the consistency principle for attitude change instruction; and (3) to determine what effect the individual difference variable integrative complexity had on the degree of attitude change when subjects were presented with integrated and non-integrated treatments.

Carl Hovland's persuasive communication model has been described as being based on stimulus-response learning theory and described with a four-part question: "Who says what to whom with what effect?" (Hovland, 1953). This framework can be translated into a flow diagram:



After defining one's objective, in terms of changing some specified attitude, one must look carefully at the audience characteristics to determine who would be a believable role model - credible communicator. Next one must also look carefully at the content to determine what would be a believable communication.

Much theoretical research has been conducted in using this model for changing the attitude of preservice teachers toward science teaching. Since several studies reported that elementary teachers have a negative attitude toward teaching science, Shrigley, a science teacher himself, conducted a series of investigations following Hovland's framework to create a theoretical persuasive communication to change this negative attitude to a more positive one. In identifying the essential elements, Shrigley (1978) made the following assumptions:

1. The "who" is the science educator, the communicator
2. The "what" is the formal, persuasive oral or written communication concerning the role of science learnings in the life of the American child
3. "Whom" is the recipient of the communication, those preparing to teach science in the elementary school
4. and "what effect" would be the change in behavior, the learned result on the part of the teachers; the response

Investigating the first part of the four-part question, Shrigley (1976) polled elementary education majors to identify characteristics of a science communicator who would be perceived as credible. The results indicated the following perceived characteristics:

1. Refers to practical teaching activities in class

2. Has taught science to children
3. Assumed responsibility for teaching science content
4. Models teaching modes similar to those proposed for children
5. Assists science professors in designing science courses
6. Counsels student teachers
7. Assists inservice teachers (p. 451)

In 1978, Shrigley also investigated the second part of Hovland's four part question to establish the content of a credible communication. By polling science educators across the United States, he was able to identify the following six major catagories of this content:

1. Science develops logical and critical thought, a means to independent learning.
2. Science provides the active, hands-on experience necessary for children to practice inquiry skills.
3. Science is motivating; it enhances the curiosity of children.
4. Science supports and enriches other areas of the elementary school curriculum.
5. Science learnings are necessary for coping with the crises in our technological society.
6. Science provides the child a necessary conceptual understanding of the physical and natural environment. (p. 337)

The "whom" was left simply as preservice elementary teachers. To determine the "what effect", he (1974a, 1974b) designed the Shrigley Attitude Scale for Preservice Teachers, a Likert type scale which measures science attitude. In this development, science attitude was divided into two parts: attitude toward science and attitude toward science teaching. Both parts were claimed to affect science attitude. Through factor analysis, the parts were broken down even further into four attitude components: "(1) science interest, (2) handling equipment, (3) science courses and (4) antipathy toward science" (Shrigley, 1974b).

To determine the actual effect of this theoretical example, the characteristics of the credible communicator and the content were woven into a persuasive communication and pre and post attitudes were measured by the Shrigley Attitude Scale for Preservice Teachers. This is graphically represented in Figure 1:

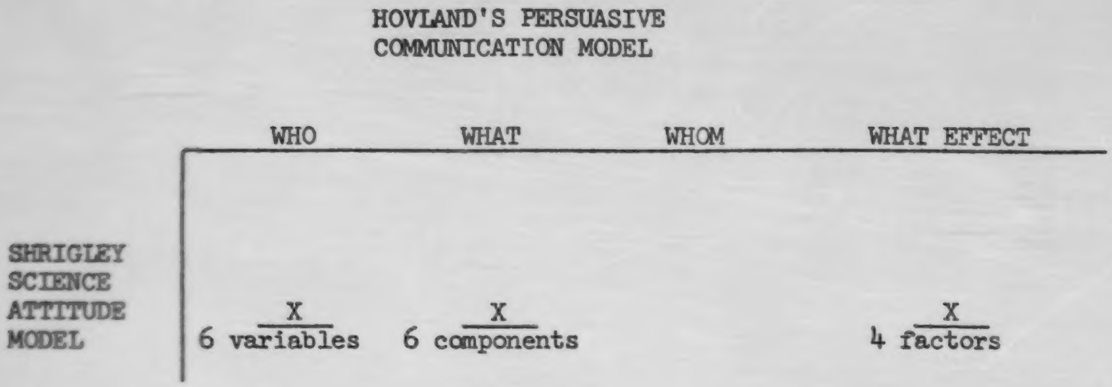

HOVLAND'S PERSUASIVE
COMMUNICATION MODEL
WHO
WHAT
WHOM
WHAT EFFECT
SHRIGLEY
SCIENCE
ATTITUDE
MODEL
X
6 variables
X
6 components
X
4 factors

FIGURE I

SHRIGLEY'S THEORETICAL SCIENCE EXAMPLE MAPPED ONTO HOVLAND'S FRAMEWORK

Whereas this persuasive communication approach to attitude change deals specifically with teaching pertinent facts relevant to the attitude, it does not establish relationships between the cognitive components and the attitudes to which they are related. These relationships need to be considered in light of current instructional design theory. Effective instructional design by the consistency principle requires a match between the objective, the learning activity, and the evaluation (Instructional Development Institute, 1972, Wood, 1976, Merrill et al, 1979). This principle can also be mapped onto Hovland's framework as shown in Figure 2. Hovland's four-part question again is represented across the top of the figure. This time, the "what" of the content and "what effect" measured should be isomorphic.

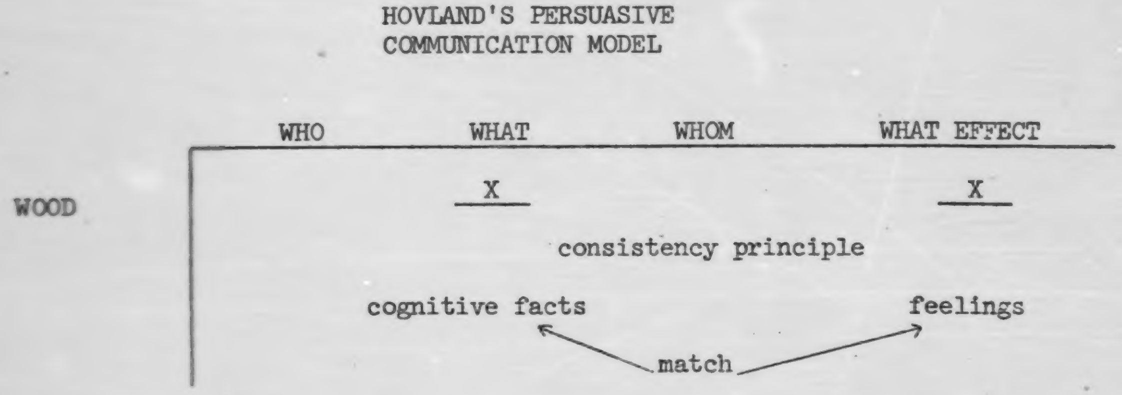

HOVLAND'S PERSUASIVE
COMMUNICATION MODEL
WHO
WHAT
WHOM
WHAT EFFECT
WOOD
X
X
consistency principle
cognitive facts
feelings
match

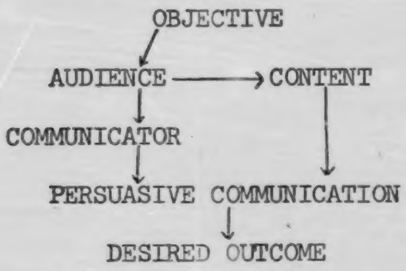
FIGURE 2

THE CONSISTENCY PRINCIPLE MAPPED ONTO HOVLAND'S FRAMEWORK

For the persuasive communication to follow this principle, an elaboration of the relationship between the facts and feelings that comprise one's attitude on a subject needs to be added to the cognitive components described earlier. A second persuasive communication was developed which was made up of the 6 credible communicator characteristics, 6 content components, and an elaboration of the relationship to the four factors that comprise a science attitude.

In this communication, no consideration was given to the "whom" variable except for the assumption that they would be "those preparing to teach science in the elementary school" (Shrigley, 1978, p. 335). One cannot ignore the literature which contends that organismic variables need to be considered in information processing. Cronbach states that "applied psychologists should deal with treatments and persons simultaneously. Treatments are characterized by many dimensions; so are persons . . . We should design treatment, not to fit the average person, but to fit groups of students with particular aptitude patterns. Conversely, we should seek out aptitudes which correspond to . . . modifiable aspects of the treatment" (1957, p. 168).

Following this theory, Hovland's persuasive communication model changes to S-O-R theory and the flow diagram becomes:



As in the S-R model, one begins by defining the specific objective. The audience retains the same influence in determining the credible communicator, although it also contributes to the determination of the content of the persuasive communication.

Since attitudes are considered to be made up of parts, the cognitive, the affective and the behavioral (Katz and Stotland, 1959, Rosenberg and Hovland, 1960), and since this study was investigating the importance of the consistency principle for affective instruction, integrative complexity (the ability to integrate information and abstract concepts in the environment (Harvey, 1966, Goldstein and Blackman, 1978)), was chosen as the individual difference variable which should have a significant influence on the content of the persuasive communication. The integrative complexity component can be mapped onto Hovland's framework as in Figure 3. Harvey's integrative complexity research clarifies the "whom" since it more carefully describes individual differences across the concrete to abstract spectrum which was left undefined in Shrigley's previous research.

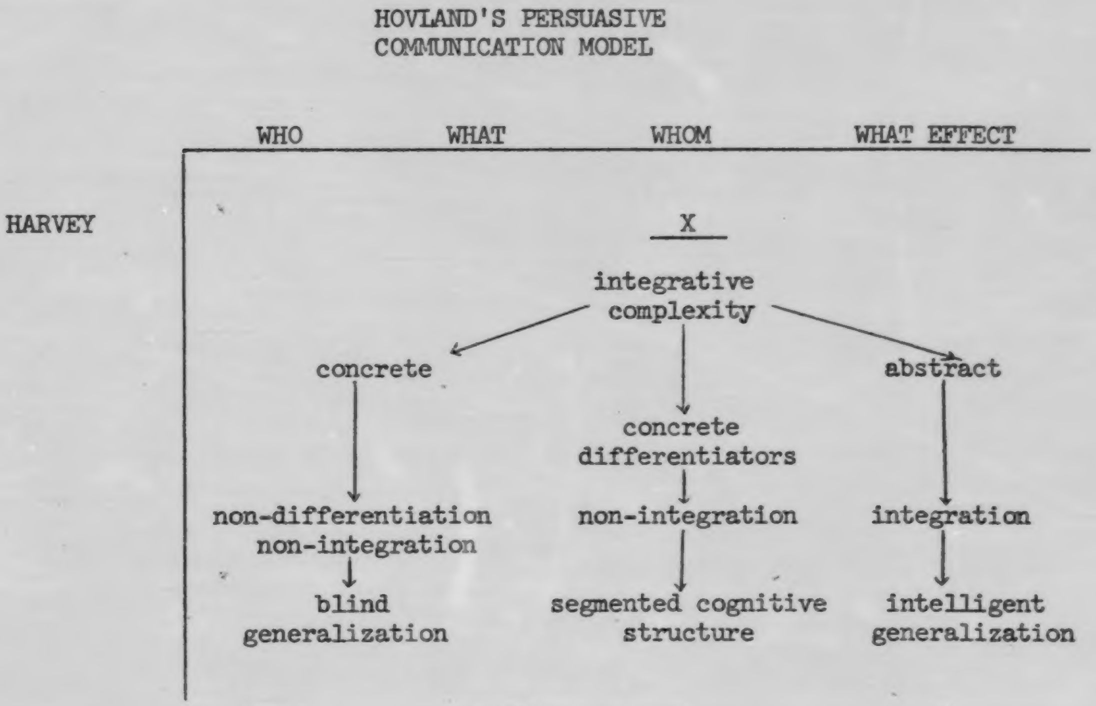

HOVLAND'S PERSUASIVE COMMUNICATION MODEL
WHO
WHAT
WHOM
WHAT EFFECT
HARVEY
X
integrative complexity
concrete
abstract
concrete differentiators
non-differentiation non-integration
non-integration
integration
blind generalization
segmented cognitive structure
intelligent generalization

FIGURE 3

THE PLACE OF INTEGRATIVE COMPLEXITY ON HOVLAND'S FRAMEWORK

Differences on the abstract-concrete continuum are explained in terms of differentiation and integration. Concrete subjects who fail to differentiate stimuli of closely related concepts will relate Shrigley's six cognitive elements about the importance of teaching science and their feeling toward science to the four factors that make up their science attitude without it actually stated. Abstract thinkers, who have the ability to differentiate information and integrate it into existing information in their cognitive structure if arguments are plausible will be able to integrate the six components about the importance of teaching science with their feelings toward science (the four factors that make up their science attitude) and thus change their science attitude also (see Figure 4).

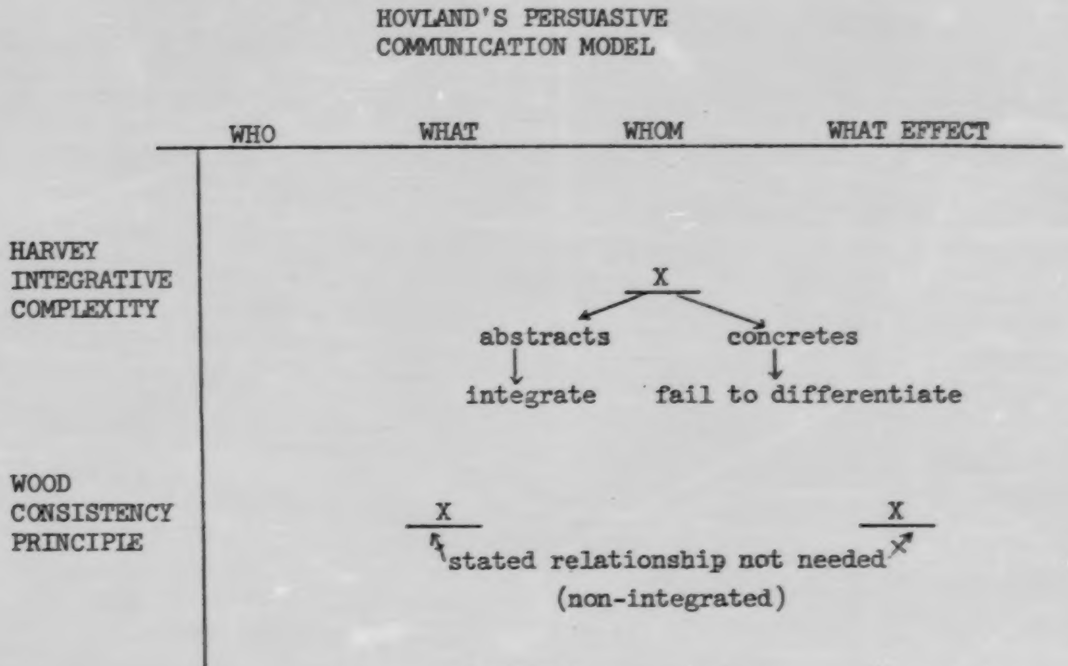

HOVLAND'S PERSUASIVE COMMUNICATION MODEL
WHO
WHAT
WHOM
WHAT EFFECT
HARVEY INTEGRATIVE COMPLEXITY
X
abstracts
concretes
integrate
fail to differentiate
WOOD CONSISTENCY PRINCIPLE
X
X
stated relationship not needed
(non-integrated)

FIGURE 4

THE CONSISTENCY PRINCIPLE AND LEVEL OF INTEGRATIVE COMPLEXITY FOR ABSTRACT OR CONCRETE THINKERS

Further, it is assumed that these six cognitive elements will not be sufficient information for changing the science attitude of concrete differentiators who maintain segmented views and do not relate new information into existing unrelated information. The communication would contain sufficient information only to change attitudes about the importance of teaching science in the elementary school. The information and the objective would be consistent and there would be no need for the subjects to integrate the importance of science into their knowledge about general science attitude. However, the objective is to change science attitude, so this cognitive information should not be sufficient to meet the objectives since it does not contain the structurally important relationships (see Figure 5). An additional segment of the persuasive communication which discusses these relationships theoretically should be necessary.

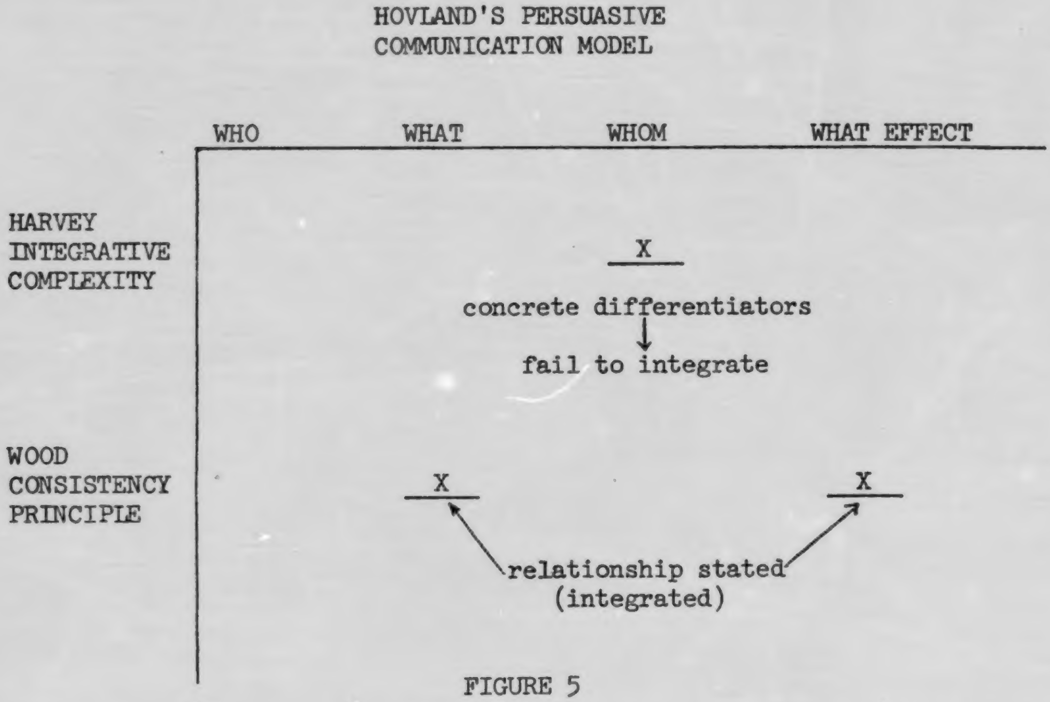

HOVLAND'S PERSUASIVE
COMMUNICATION MODEL
WHO
WHAT
WHOM
WHAT EFFECT
HARVEY
INTEGRATIVE
COMPLEXITY
X
concrete differentiators
fail to integrate
WOOD
CONSISTENCY
PRINCIPLE
X
X
relationship stated
(integrated)

FIGURE 5

THE CONSISTENCY PRINCIPLE AND LEVEL OF INTEGRATIVE COMPLEXITY
FOR CONCRETE DIFFERENTIATORS

Specifically, this study asks the following questions:

1. Do persuasive communications formed from Shrigley's theoretical research change the attitude of preservice teachers toward science?
2. Will an integrated persuasive communication change the attitude of preservice teachers toward science more than a non-integrated persuasive communication?
3. Does integrative complexity mediate the stimulus and response as proposed so that a non-integrated persuasive communication will change science attitude more in some preservice teachers and an integrated persuasive communication will change science attitude more in others?

These questions can be translated into the following hypotheses:

H_1: Preservice teachers who listen to integrated persuasive communications will show significantly more positive change in attitudes toward science than those who listen to no communication.

H_2: Preservice teachers who listen to non-integrated persuasive communications will show significantly more positive change in attitudes toward science than those who listen to no communication.

H_3: Preservice teachers who listen to integrated persuasive communications will show significantly more positive attitudes toward science than those who listen to non-integrated persuasive communications.

H_4: Preservice abstract or concrete thinkers who listen to a non-integrated communication will show significantly more positive change in attitude toward science than those concrete differentiators who listen to the same communication.

H_5: Preservice abstract/concrete thinkers who listen to an integrated treatment will show no more positive change in attitude toward science than the concrete differentiators who listen to the same communication.

H_6: Preservice abstract/concrete thinkers who listen to a non-integrated treatment will show no difference in change in attitude toward science than if they listen to an integrated treatment.

H_7: Preservice concrete differentiators who listen to an integrated persuasive communication will show significantly more positive change in attitude toward science than if they listen to a non-integrated persuasive communication.

A pretest, posttest, control group design was used with subjects block randomized into one of three groups: integrated, non-integrated, or control, by their level of integrative complexity. The Conceptual Systems Test, a 48-item, five choice objective personality test designed by Harvey and Hoffmeister (1978) was used to determine the level of integrative complexity. This test was chosen for several reasons. First of all, the test has been designed by Harvey, who originally conceived the four levels of abstraction and developed the very highly valued This I Believe (TIB) test, and has high content and construct validity (Harvey, 1966). Secondly, it has been designed for group administration of subjects grades seven and over. This test has been used extensively with undergraduates (Epting and Wilkins, 1974). Third, it is a published test and its results may be related to other studies using this instrument. Fourth, it is an objective test which is easier to score than the TIB, another measure of integrative complexity, and not dependent upon subjective evaluation. Fifth, administration of the test takes only 25 - 30 minutes. Sixth, "teachers have been classified according to this scheme in studies of teacher effectiveness" (Buros, 1978, p. 757), and therefore it can be used with preservice teachers who eventually will make up the teacher population.

Upon the recommendation of Hoffmeister (1979), subjects were grouped into low, middle, and high groups with low representing abstract, middle as concrete differentiators, and high as concrete thinkers.

The Shrigley Attitude Scale for Preservice Teachers described previously was used as the pre and post measure of attitude change. A respectable 0.89 and 0.912 coefficient alpha indices of reliability were yielded on the pre and post tests respectively.

Ninety-three volunteers of preservice elementary teachers enrolled in an instructional media course participated in this investigation. Subject distribution is shown in Table 1.

Table 1

Subject Distribution

	TREATMENT A	TREATMENT B	TREATMENT C	
	Non-Integrated	Integrated	Control	Total
High	8	9	8	25
Middle	15	18	15	48
Low	4	3	5	12
Subtotal	27	30	28	85
Unclassifiable	4	2	2	8
Total	31	32	30	93

The non-integrated treatment was a videotaped discussion of the 6 cognitive components with the weaving in of the 6 statements to establish communicator credibility. The integrated treatment was also a videotaped discussion as in the non-integrated treatment with an additional segment which discussed the relationship between the importance of science teaching and one's feelings toward science. To determine if the two persuasive communications were effective in changing attitudes of preservice teachers, a 3X2 analysis of variance with repeated measures with three levels of treatment, integrated, non-integrated and control as the between subjects A factor and the pre and post-test scores as the within subjects J factor. Results are shown in Table 2 and Figure 6.

Table 2

Summary Table for Comparing Pre- and Post-test Scores
Across the Three Treatment Conditions

Source of Variation	Sums of Squares	Mean Squares	df	F-Ratio
Between Subjects (A)	565.30	282.65	2	1.138
Error	22357.51	248.42	90	
Within Subjects (J)	149.94	149.94	1	7.47 **
AJ	129.10	64.55	2	3.22 *
Error	1806.46	20.07	90	

*p .05

**p .01

	PRE	POST
(A) Non-Integrated	65.19	68.39
(B) Integrated	62.65	65.34
(C) Control	62.26	62.65

FIGURE 6

These results show a significant interaction, so three tests of contrasts comparing the pre- and post-scores of each treatment were conducted. Family-wise error has been controlled using the Tukey WSD on the follow-up tests. Results of this analysis are shown in Table 3.

Table 3

Follow-up Test Results Comparing Pre- and Post-Test Scores on the Three Treatments

Pre-Post Contrast	Difference	Obtained T	df	Critical Value of T
Non-Integrated	3.1935	3.468 *	30	2.04
Integrated	2.6875	2.224 *	31	2.04
Control	0.6000	0.477	29	2.05

*p .05

These results indicate a significant difference between the pre- and post-test scores of both the non-integrated treatment group and the integrated treatment group.

The relationships among the concretes, concrete differentiators, and abstract groups in the three treatments were also investigated.

Due to the theoretical prediction that both concretes and abstracts would manifest a greater attitude change than the concrete differentiators, and the dearth of samples on each extreme, the two groups were combined into the 'high' group to increase the power of discrimination between cell means. Concrete differentiators remained intact and will be called the 'medium' group.

Analysis of variance with repeated measures in a 3X2X2 design with three treatments, two levels of integrative complexity, and pre- and post-measures was used to test these last four hypotheses. Since proportional sample sizes were needed to run this analysis, three subjects had to be randomly eliminated from the medium, integrated group and one subject randomly eliminated from the high, control group. Proportionality thus was achieved with 12 subjects in the high, and 15 subjects in the medium groups across each treatment condition.

The results designated in Table 4 reveal neither a triple interaction nor any two-level interactions. The within-subjects variable was significant as expected and consistent with the findings in Table 2. Of interest to this analysis was the difference in pre- and post-scores among each level of integrative complexity and treatment. Since no triple interaction resulted, significant differences between pre- and post-scores on both levels of high and medium integrative complexity in each treatment were examined. Results of this analysis are recorded in Table 5. Differences are shown in Figure 10.

Table 4

Summary Table for Testing the Individual Difference Variable

Source of Variation	Sums of Squares	Mean Squares	df	F-Ratio
Between Subjects				
(A) - 3 Treatments	655.05	372.52	2	1.482
(B) - High-Medium	12.22	12.22	1	0.055
(AB) - Interaction	469.29	234.64	2	1.061
Error	16580.19	221.07	75	
Within Subjects				
(J) - Pre-Post	160.01	160.01	1	8.632 **
(AJ) - Interaction	58.38	29.19	2	1.575
(BJ) - Interaction	5.96	5.96	1	0.322
(ABJ) - Interacti[illegible]	14.99	7.49	2	0.404
Error	1390.16	18.54	75	

**p .01

Table 5

Follow-up Tests for Comparing Pre- and Post-Scores for High and Medium Groups in Each Treatment

Pre-Post Contrast	Difference	Obtained T	df	Critical Value of T
High, Non-Integrated	4.3333	3.916 *	14	3.155
Medium, Non-Integrated	1.8667	1.182	14	3.155
High, Integrated	2.8333	1.166	14	3.155
Medium, Integrated	2.6000	1.809	14	3.155
High, Control	0.0833	0.057	14	3.155
Medium, Control	0.4667	0.297	14	3.155

*p .05

	Non-Integrated		Integrated		Control	
	Pre	Post	Pre	Post	Pre	Post
High	61.67	66.00	63.58	66.42	62.00	62.08
Medium	68.00	69.87	60.53	63.13	61.53	62.00

FIGURE 7

COMPARISON OF PRE- AND POST-SCORES FOR HIGH AND MEDIUM GROUPS IN EACH TREATMENT

Non-integrated and integrated treatment data indicate that a more positive attitude resulted after listening to the persuasive communication; however, only the difference for the high subjects in the non-integrated treatment condition was significant.

These results indicate for the other groups that the changes in attitude were not significantly different from each other, although the gain scores were in the predicted direction.

Discussion and Critical Analysis of Results

Support has been found for the predicted change in attitude after listening to the integrated treatment or non-integrated treatment but not for the control group. These results indicate that Shrigley's theoretical example of a systematically designed persuasive communication using Hovland's model can yield a positive change in attitude toward science. The communicator and communication components which made up both the integrated and non-integrated treatments can now be interpreted as essential and effective in bringing about an attitude change.

The predicted difference between the non-integrated and integrated treatment attitude scores was not supported even though the integrated treatment was designed according to the consistency principle, that is, by adding four components, which directly matched the type of questions on the evaluation instrument (Shrigley Attitude Scale for Preservice Teachers), to the content of the non-integrated persuasive communication. These results indicate that the inclusion of the additional section to the persuasive communication which explicitly establishes the relationship between attitude toward science and the factors which make up one's attitude toward science is not necessary.

The sensitivity one has to having one's attitude changed cautions instructional designers against including statements which specifically mention audience attitudes. Statements which declared that the communicator was trying to manipulate the audience's attitude were carefully avoided; however, descriptions of how their attitude on the four factors related to their science attitude were explicit. The mention of attitudes, combined with administration of a science attitude pre-test may have cued, or established a predisposed resistance to the message. This may mean that in a persuasive communication one-to-one correspondence in instruction-evaluation may not be desirable. It should be noted that the effects of the additional segment in the integrated treatment did not prevent a positive change in attitude from occurring. What is also important to note is that the six components of the non-integrated treatment were included and may have caused the change in attitude in spite of the negative effects possible caused by mentioning attitudes.

Due to the fact that the abstract and concrete thinkers were predicted to obtain the same results, the former because of intelligent differentiation and integration and the latter because of lack of differentiation, both were combined in order to compare their results with the results of the concrete differentiators across pre- and post-test scores as posed in hypotheses 4 through 7. After calculating the analysis of variance with the combined group, difference was found between pre- and post-scores for only the high abstract/concrete, non-integrated treatment group. In analyzing these individual difference results, it is important to keep in mind the predictions for each cell which are shown in Figure 8.

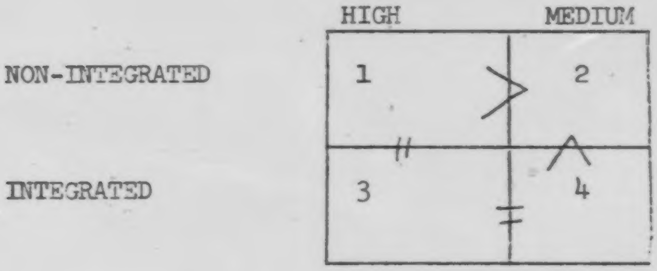


FIGURE 8

PREDICTED RESULTS FOR THE INDIVIDUAL DIFFERENCE VARIABLE

According to the manner in which concretes, abstracts, and concrete differentiators differ in their cognitive processing, high subjects who listen to the non-integrated treatment should have a greater change in attitude than concrete differentiators, medium subjects, who listen to the same communication. The one-to-one correspondence between the communication and evaluation advocated by the consistency principle is not needed to change attitudes for this high group. Cells 1 and 3 from Figure 8, therefore, should be equal since these relationships are not, in fact, present in the non-integrated treatment (cell 1) and are present, although not necessary, in the integrated treatment (cell 3).

The one-to-one correspondence of the consistency principle, however, was predicted to be essential in designing instruction for concrete differentiators because of their segmented cognitive structure. This means that cell 4 should reflect a greater change in attitude than cell 2 since the concrete differentiators were presented with integrated information. The integrated treatment should yield equal results in cells 3 and 4 for both high and medium groups since relationships were established for both those who fail to differentiate or integrate and those who do not.

The results indicate a significant change in attitude in cell 1 from Figure 8, but not for any of the others. This means that for the high integrative complex subjects, the persuasive communication may be designed based on Shrigley's work without one-to-one correspondence of the instruction and evaluation. For the other cells, stated relationships may or may not be needed to elicit a significant change in attitude by means of a persuasive communication.

To determine if the integrated treatment was more effective than the non-integrated treatment for either level of integrative complexity, analysis of variance was applied to the gain scores. No significant difference resulted between the means. Although all of the means in each cell were in the predicted direction, the high variance in each cell reduced the power of the test to detect any differences. Based on this analysis, it is important to emphasize that the cell means cannot be legitimately attributed to different populations, and are not, therefore, statistically different from each other. Retesting this hypothesis with a larger sample representing the abstract and concrete groups is essential to determine if the consistency principle should be followed in developing different persuasive communications for different levels of integrative complexity.

These results, indicating equality in the cell means, are inconsistent with the theoretical basis of cognitive processing in concrete-abstract thinkers. Considering all the research conducted in defining the characteristics of concrete/abstract thinkers and the significant results showing that Shrigley's six components elicit a positive attitude change, it is unlikely that non-significance can be attributed to faulty definition of the subjects by integrative complexity. Rather, careful inspection of the content of the additional segment in the integrated treatment which discusses the relationship between the importance of teaching science and the four affective factors that make up one's attitude toward science is warranted. Examples used in establishing relationships in the treatment must be examined to determine if they are significantly relevant to the audience. If relevance of the examples cannot be established, they should be changed. Also, the mention of attitudes in the integrated persuasive communication must be tested to determine if the treatment is cueing the audience to the objective of the treatment. Changes in the additional segment of the integrated communication should be made and tested before any significant conclusions are drawn about applying the consistency principle to the design of a persuasive communication for subjects differing in level of integrative complexity.

Conclusions

Presentation of the persuasive communication resulted in a change in attitude for both the integrated and non-integrated treatment groups. There was no significant difference in the magnitude of the change in attitude between the non-integrated and integrated groups, both treatments apparently being equally as effective. Differences between treatments, pre- and post-scores, and level of integrative complexity were analyzed next. In order to examine the results more closely, concretes and abstracts were combined into the high group and compared to the concrete differentiators (the medium group). The statistical tests indicated that the only group to achieve a significant gain in attitude was the high subjects who listened to the non-integrated communication. The high, non-integrated group's gain score, however, cannot be said to be significantly greater than that of any other group.

Implications of the Study

This study has shown the empirical effectiveness of Shrigley's theoretical science persuasive communication. The combination of the essential components of a persuasive communication and the establishment of the perceived credibility of the communicator resulted in significant positive change in attitude. The importance of this result touches several important areas. First of all, the results indicate that science attitude, in fact, can be changed. Knowing this may be the first step in increasing the amount of science teaching occurring in the elementary school.

Next, contrary to common opinion, science attitudes can be changed with as little as a twenty-minute persuasive communication. This is especially important in dealing with in-service programs for teachers. Time is very critical with these programs as they are typically very short, one-day sessions.

Finally, but most importantly for instructional development models, support is indicated for designing a persuasive communication using the systematic strategy of investigating each piece of Hovland's framework as Shrigley did.

Further investigation needs to be conducted to determine if the consistency principle needs to be followed in designing a persuasive communication to elicit a change in attitude for the concrete differentiators; if it is necessary for the design of persuasive communications for high abstracts or concretes; and if matching instruction to evaluation really interferes with attitude change because of the direct way it presents information and relationships (in this case, between attitudes and behaviors).

BIBLIOGRAPHY

Cronbach, L. J. "The Two Disciplines of Scientific Psychology." American Psychologist, 12 (1957), 671-684.

Gabel, Dorothy, and Peter Rubba. "Attitude Changes of Elementary Teachers According to the Curriculum Studied During Workshop Participation and Their Role as Model Science Teachers." Journal of Research in Science Teaching, 16 (1979), 19-24.

Goldstein, Kenneth, and Sheldon Blackman. Cognitive Style: Five Approaches and Relevant Research. New York: John Wiley and Sons, 1978.

Harvey, John, and Daniel G. Hays. "Effect of Dogmatism and Authority of the Source Communication Upon Persuasion." Psychological Reports, 30 (1972), 119-122.

Harvey, O. J. "Authoritarianism and Conceptual Functioning in Varied Conditions." Journal of Personality, 31 (1963), 462-470.

Harvey, O. J. "Some Situational and Cognitive Determinants of Dissonance Resulution." Journal of Personality and Social Psychology, 1, No. 4 (1965), 349-355.

Harvey, O. J. "System Structure, Flexibility and Creativity." Experience Structure and Adaptability, ed. O. J. Harvey. New York: Springer Publishing Co. Inc., 1966, 39-63.

Harvey, O. J. "Conceptual Systems and Attitude Change." Attitude, Ego-Involvement and Change, eds. Carolyn W. Sherif and Muzafewr Sherif. New York: John Wiley and Sons, Inc., 1967.

Harvey, O. J. "Beliefs and Behavior: Some Implications for Education." Science Teacher, 37, No. 9 (1970), 10-15.

Harvey, O. J., and G. D. Beverly. "Some Personality Correlates of Concept Change Through Role Playing." Journal of Abnormal and Social Psychology, 63 (1961), 125-130.

Harvey, O. J., and D. G. Hays. "Effect of Dogmatism and Authority of the Source of Communication Upon Persuasion." Psychological Reports, 30 (1972), 119-122.

Harvey, O. J., D. E. Hunt, and H. M. Schroder. Conceptual Systems and Personality Organization. New York: Wiley, 1961.

Harvey, O. J., D. E. Hunt, and H. M. Schroder. Conceptual Systems and Personality Organization. New York: Wiley, 1963.

Harvey, O. J., Misha Prather, B. Jack White, and James K. Hoffmeister. "Teachers' Beliefs, Classroom Atmosphere and Student Behavior." American Educational Research Journal, 5, No. 2 (1968), 151-165.

Harvey, O. J., John W. Reich and Robert S. Wyer. "Effects of Attitude Direction, Attitude Intensity, and Structure of Beliefs Upon Differentiators." Journal of Personality and Social Psychology, 10 (1968), 472-478.

Harvey, O. J., and Harold M. Schroder. "Cognitive Aspects of Self and Motivation." Motivation and Social Interaction, ed. O. J. Harvey. New York: The Ronald Press Company, 1963.

Harvey, O. J., and Robert Ware. "Personality Difference in Dissonance Resolutions." Journal of Personality and Social Psychology, 7, No. 2 (1967), 227-230.

Harvey, O. J., B. J. White, M. S. Prather, R. D. Alter, and J. K. Hoffmeister. "Teachers' Belief Systems and Preschool Atmosphere." Journal of Educational Psychology, 57, No. 6 (1966), 373-381.

Hoffmeister, J., Personal Communication, April 19, 1979.

Hovland, Carl Il, Irving L. Janis and Harold H. Kelly. Communication and Persuasion. New Haven: Yale University Press, 1953.

Instructional Development Institute. "Instructional Development System." The Systematic Development of Instruction: An Overview and Basic Guide to the Literature, ed. Paul A. Twelker, Floyd D. Urbad and James E. Buck. Corvallis, Oregon: United States International University in Oregon, 1972.

Katz, D., and E. Stotland. "A Preliminary Statement to a Theory of Attitude Structure and Change." Psychology: A Study of a Science, ed. S. Koch. New York: McGraw-Hill Inc., 1959.

Merrill, M., R. Richards, R. Schmidt, and N. Wood. Instructional Quality Inventory. Orem, Utah: Courseware, Inc., 1978.

Rosenberg, M. J., and C. I. Hovland. "Cognitive, Affective and Behavioral Components of Attitudes." Attitude Organization and Change. eds. C. I. Hovland and M. J. Rosenberg. New Haven: Yale University Press, 1960.

Shrigley, Robert L. "The Attitude of Pre-Service Elementary Teachers Toward Science." School Science and Mathematic, 74, No. 3 (1974a), 243-250.

Shrigley, R. L. "Correlation of Science Attitude and Science Knowledge of Preservice Elementary Teachers." *Science Education*, 58, No. 2 (1974b), 143-151.

Shrigley, Robert L. "Credibility of the Elementary Science Methods Course Instructor as Perceived by Students: A Model for Attitude Modification." *Journal for Research in Science Teaching*, 13, No. 5 (1976), 449-453.

Shrigley, Robert L. Personal Correspondence to Mr. Hannapel. October 27, 1977.

Shrigley, Robert L. "The Persuasive Communications Model: A Theoretical Approach for Attitude Change in Science Education." *Journal of Research in Science Teaching*, 15, No. 5 (1978), 335-341.

Shrigley, Robert L. Personal Interview, February 5, 1979.

Shrigley, Robert L., and Cecil R. Trueblood. "Designing a Likert Type Scale to Assess Attitude Toward Metrication." *Journal of Research in Science Teaching*, 16 (1979a), 73-78.

Suedfeld, Peter and Siegfried Streufert. "Information Search as a Function of Conceptual and Environmental Complexity." *Psychonomic Science*, 4, No. 10 (1966), 351-352.

Wood, Norman. "Prediction of Student Performance on Rule-Using Tasks from the Diagnosis of Instructional Strategies." PhD dissertation, Brigham Young University, 1976.

TITLE: Systematized Feedback and Mathematics Performance

AUTHOR: Michael J. Hannafin

SYSTEMATIZED FEEDBACK AND MATHEMATICS PERFORMANCE

Michael J. Hannafin
Department of Educational Technology
Arizona State University

Paper presented at the annual meeting of the Association for Educational Communication and Technology (AECT) - Research and Theory Division, Denver, Colorado (April, 1980).

ABSTRACT

Feedback programs have produced inconsistent effects on student performance. The major contributing factors have been inconsistent definitions of feedback and feedback procedures used in various studies. Variations in the feedback recipients (students, teachers, parents) and a lack of careful utilization of the instructional content in the feedback systems have also contributed to the reported inconsistencies. In addition, feedback programs have been criticized as being unrealistic in non-laboratory settings. Many programs have not adequately considered the problems presented in typical classroom settings, and have imposed relatively complex feedback programs in contrived classrooms. Systematized feedback, a curriculum- based program employed in the present study, was defined as providing knowledge of results of student performance to both students and teachers: a) related to established instructional objectives; b) within an established instructional context; and c) on a regularly prescribed basis.

A posttest-only, internal-external control group design was used in the present study. Three sixth grade classes served as subjects. All classes utilized a "step" approach to math instruction, where students advanced through a pre-determined sequence of math skills at individual rates. Two classes, each taught by the same teacher, were used to measure treatment effects. One class served as an internal control group, receiving only math instruction. The other class received math instruction and systematized feedback. The remaining class, taught by a different teacher, served as an additional external control class. The external control class, included to control for possible teacher bias, received only math instruction.

The systematized feedback class was administered a math skill inventory to determine the individual skill status of each student. Student scores were provided to the teacher, who subsequently distributed the results to the students. Students individually recorded their skills as mastered, instructional, or not mastered on skill profile sheets. Students were instructed for a two week period, and administered an update quiz which covered skills not yet mastered. Student quizzes were scored, returned to the teacher for review, and subsequently distributed to the students for feedback and profile updating. This procedure continued for twelve weeks. All students were administered a 25 item math computation proficiency test at the end of the twelve week period.

Results of an ANOVA comparing the scores of the three classes indicated significant differences ($p < .02$). Means and standard deviations for the three classes were: systematized feedback ($\bar{X}=21.20$; S.D.=3.07), internal control ($\bar{X}=18.75$; S.D.=3.67), and external control ($\bar{X}=18.61$; S.D.=3.47). The systematized feedback class scored significantly higher than the control groups on the math proficiency test, while no significant differences were obtained between the two control groups. The observed treatment effect and the non-significant differences between the control classes suggests that the results are valid, and not simply a function of teacher bias.

Feedback is of significant value when applied in a systematic manner. The present study confirms the effectiveness and practicality of feedback based programs in "real world" settings. Feedback programs should systematically include instructional content, feedback procedures that include both teachers and students, and provisions for assuring compatability with existing instructional settings.

SYSTEMATIZED FEEDBACK AND MATHEMATICS PERFORMANCE

Michael J. Hannafin
Arizona State University

The benefits of providing delayed feedback in the instructional process have been well documented in controlled settings (Sturges, Sarafino, and Donaldson, 1968; More, 1969; Kulhavy, 1972; Sassenrath, 1975). Yet comparatively little research demonstrating applicability of delayed feedback in natural classroom settings has been reported. Limited attempts to apply delayed feedback programs in natural classroom settings have often produced contradictory results (e.g., Surber & Anderson, 1975, versus Newman, Williams, & Hiller, 1974). The determination of the practical effectiveness of delayed feedback in natural classroom settings is imperative.

The present study examined the effects of providing delayed, systematized feedback on student test scores on math computation proficiency tests. Delayed systematized feedback was defined as providing knowledge of test results on skill quizzes to both students and teachers: a) related to established instructional objectives; b) within an established instructional context, i.e., natural classroom setting; c) on a bi-weekly basis; and d) one day following the completion of the quiz.

Several important components of delayed feedback programs have been identified. Sturges (1972 a) suggested that the effecitveness of delayed feedback programs is contingent on the nature of the stimuli present during the feedback, how the students or subjects respond to the feedback, and the relevance of the feedback stimuli to the test measures. Kulhavy (1977) noted that although feedback should be used frequently in the instructional process, the availability of feedback materials needs to be restricted.

He reasoned that when feedback materials are too readily available, students might copy responses rather than utilizing the correcting function of feedback to confirm the accuracy of their responses. Kulhavy also suggested that the instructional level upon which the feedback is based must be appropriate for the intended learners. Feedback systems produce only minimal effects when students have very little confidence in their responses. Consequently, the required learning tasks must be reasonably attainable for delayed feedback strategies to be effective (Kulhavy, 1977). Sturges (1972 b) suggested that the activity immediately following feedback is also critical in feedback programs. Given opportunities for self-correction or practice following feedback, students' performance was improved as a result of the feedback (Sturges, 1972 b). In effect, the identified components suggest that feedback must be systematically applied in order to be maximally effective.

The manner in which delayed feedback is operationally defined is also an important factor. Delayed feedback has been frequently defined as providing knowledge of results of test performance to students. However, the different ways in which such definitions have been operationalized have been a source of concern. Kulhavy (1977) attributed many of the reported inconsistencies among delayed feedback programs to operational definitional differences.

The manner in which knowledge of results is provided has also been considered an additional source of potential variability. Sturges (1969) noted that knowledge of results in delayed feedback programs should be informative, i.e., must include information related to criterion measure items and response alternatives. Gilman (1969) has suggested that the process of providing knowledge of results be modified to provide greater guidance to the learners. The author found that feedback which simply identifies responses as correct or incorrect was not as effective as providing knowledge of results with guided elaboration. Guided elaboration, where both correct and incorrect responses are verified through a structured review of the relevant content, was more effective in improving student performance than providing only knowledge of response accuracy (Gilman, 1969).

An additional definitional problem reported in feedback literature is related to the immediate vs. delayed feedback dichotomy. Since the terms immediate and delayed are relative terms, they have been operationally defined within each individual study. Consequently, the generalizability of research findings has been somewhat limited (Peck & Tillema, 1979, Note 1).

Attempts have also been made to identify maximally effective delay intervals as applied in delayed feedback programs. Studies employing delayed feedback techniques have focused primarily on retention of factual information. Research in written prose learning generally indicates that feedback delays from one-to-two days are effective in improving subsequent student performance. English and Kinzer (1966) found that feedback delays of one hour or two days were superior to either immediate feedback or feedback delayed one week. More (1969) found that delays of two-and-one-half hours or one day were superior to either immediate feedback or feedback delayed four days. However, the primary means for assessing student performance in these studies has been the use of multiple choice tests. The effectiveness of feedback programs in process-oriented content areas has not been well documented. Computational mathematics, for example, requires both basic factual memory and process-oriented applications. Existing feedback research does not provide clear guidelines for the development of feedback programs process-oriented content areas such as mathematics.

The use of feedback systems in relearning information is also an important consideration. However, the manner in which feedback information should be subsequently utilized has not been clearly established. While this is critical to the development of an effective feedback program, research has not conclusively identified how feedback information should be subsequently utilized in order to be maximally effective. Surprisingly little research has been reported pertaining to the role of the instructor in teacher-directed learning settings. In such settings, the teacher typically controls the content, presentation rate, and total time provided for instruction. Since these are potent variables in facilitating student learning, the role of the teacher needs to be investigated.

Method

Subjects

The subjects were 67 students assigned to one of three sixth grade mathematics classes in a non-tracked suburban elementary school. Non-tracked refers to the essentially random class assignment procedures used by the school system. The three classes were selected because each used a "step" approach to mathematics instruction, where students advanced through a predetermined sequence of mathematics skills at individual rates. Two classes were taught by the same teacher, and the remaining class was taught by a second teacher. One class was the systematized feedback group, one the internal control group, and one the external control group.

Materials

The materials used in the present study included a mathematics skill inventory, a series of sequenced mini-quizzes, student profile sheets for recording individual progress, and class record sheets for reporting overall class progress. The mathematics inventory included three test items for each of 39 specific objectives. The objectives were developed and sequence by school personnel prior to the present study and the mathematics inventory was developed by the researcher for the present study. The inventory provided information used to establish the baseline skill status for each student in the systematized feedback group. The mathematics inventory also served as the initial feedback instrument for both teachers and students regarding individual skill acquisition. Thirty-nine separate mini-quizzes, each keyed to the mathematics objectives, were used for a bi-weekly skill assessment of students in the systematized feedback group. Student performance on the mini-quizzes was the primary information source for providing the bi-weekly feedback. In addition, each student in the systematized feedback group maintained an individual skill profile sheet which included the 39 math objectives. Students individually recorded their skills as mastered (100% accuracy), instructional (67% accuracy), or not mastered (less than 67% accuracy) on their profile sheets. The skills were sequentially ordered from easiest to most difficult based upon the skill sequence defined by the school personnel. The individual skill profile sheets provided students with the means to monitor their individual progress throughout the study. Based upon individual student performance on the bi-weekly mini-quizzes, students individually updated their profiles. A class summary record sheet, which provided a student performance by objective format, provided a capsulized summary of student performance and progress throughout the study.

Criterion Measures

The criterion test used in the present study was a 25 item mathematics computation test. The computation test included skills which are typically mastered between fifth and eighth grade levels, and all skills on the computation test were also included on the mathematics inventory and mini-quizzes. The test required addition, subtraction, multiplication, and division of whole numbers, fractions, and decimals. In addition, test items related to physical geometry and measurement were included. The test, which was developed by the school staff, was administered to provide information for the present study and information for use in subsequent class scheduling. The test was a constructed response test, and was administered as a power test.

Procedures

Three classes participated in the study. Two classes were taught by the same teacher, the remaining class was taught by a different teacher. Of the two classes taught by the same teacher, one class was randomly assigned to the systematized feedback treatment. The remaining classes served as control classes.

Prior to the start of the study, the systematized feedback teacher provided students with a general introduction to the mathematic program that followed. No statement was made regarding comparisons among classes; students were not informed that their test scores would be compared with the performance of other classes. Students were administered the mathematics inventory under untimed conditions prior to the start of the program. Mathematics inventories were scored, student performance was recorded on the class record sheet and student profile sheets, and all information was returned to the teacher on the first day of the program. The teacher distributed the student profile sheets to the class with the corresponding scored mathematics inventory test. At that time, the teacher conducted a 15 minute orientation session designed to familarize the students with the relationship between their test performance and their individual profile sheets. The teacher provided instructions to the students for recording their test scores during the subsequent feedback periods provided during the study. All students then received instruction for a two week period. At the end of the two week period, students in the systematized feedback class were administered mini-quizzes covering those skills not yet mastered. Since many students had not yet been exposed to several of the more difficult skills, they were instructed to review each test item, write their answers if they felt reasonably confident they could perform the task, or mark an "X" in the answer box if they were uncertain of the correct response. The mini-quizzes were corrected, scored, and returned to the teacher and the students on the next school day. At that time, the teacher distributed the scored mini-quizzes to the students and instructed them to update their profile sheets according to the quiz results. Students were provided approximately five minutes for completing this task. The teacher then instructed the students to review their correct and incorrect answers in order to identify possible problems. Students were told to request assistance from the teacher, if needed, or to proceed with the next step in the mathematic sequence. Since students in all classes were routinely instructed to request needed assistance, this procedure simply confirmed the availability of the teacher under the new program.

The bi-weekly testing, scoring, and feedback was continued throughout a twelve week period. At the end of the twelve week period, students in both the systematized feedback class and the control classes were administered the 25 item mathematics computation test.

Results

Means and standard deviations for the mathematics computation test scores by treatment group are included in Table 1.

Insert Table 1 Here

As shown in Table 1, the systematized feedback class scored higher than either the internal control class or the external control class. Results of a one-way ANOVA indicated the difference to be significant (F=4.18, df = 2/64, $p < .02$). No significant differences were obtained between the two control groups.

Discussion

The present study examined the effects of systematized feedback on mathematics performance. The study was conducted in natural classroom settings in an attempt to extend the external validity of previous feedback studies.

The results of the present study indicate that feedback can be of significant value when applied in a systematic manner. All classes employed in the present study employed the same instructional materials, approximately the same student entry level skills based on teacher and administrator report,

Table 1

Mean Computation Test Scores, N, and Standard Deviations by Treatment Group

Computation Test Results	Treatment Group Systematized Feedback	 Internal Control	 External Control
Test Score	21.20*	18.75	18.61
S.D.	3.07	3.67	3.49
_N_	24	20	23

*$p < .02$

and the same performance documentation system required by the school. The major departures among the classes employed in the present study were that the systematized feedback class employed an instructionally integrated feedback system. Systematized feedback was regularly provided, organized, included provisions for post-feedback instruction, and was provided to both students and teachers.

In effect, systematized feedback provides a closed loop instructional system where knowledge of student performance is sensibly integrated with instruction and assessment to improve subsequent student performance. Since the major difference between the systematized feedback class and the control classes was essentially organizational in nature, the findings suggest that a more methodical approach to providing instruction in natural settings is both plausible and effective.

During the present study, no special requirements were made of the systematized feedback teacher regarding instructional style. The teacher was instructed to use the information in whatever manner deemed appropriate. However, as verified informally by the teacher, teaching style was modified as a result of the systematized feedback received during the study. The systematized feedback teacher indicated that the instruction became more focused, i.e., more skill-specific. Also, the teacher noted that student progress became contingent on demonstrable skill acquisition rather than teacher judgement. While it is impossible to partition the proportion of score variance accounted for by student versus teacher knowledge of results in the present study, the combined effect is apparent. When a teacher was provided meaningful information upon which to base modifications in teaching style, changes occurred; when such information was provided on a regular basis, as demonstrated during the present study, the teacher modified instructional strategies on an on-going basis. The result of this type of on-going instructional modification was inevitably improved student performance. Since the teacher possesses substantial control over the instructional process, the importance of including the teacher in delayed feedback programs can not be overstated. While the student is ultimately responsible for learning the information presented, the teacher typically controls what and how information is to be presented.

Several cautions which are frequently encountered in applied, action research must be considered. Although random assignment of students to classes was assumed no absolute statements of pre-program equivalence among classes can be guaranteed. Historically, however, substantial mathematics performance differences among sixth grade classes was considered very uncommon by the school administration. Also, since the researcher randomly assigned the systematized feedback class, potential teacher or subject selection bias was not a factor. Future research should systematically account for equivalence through pretest procedures or covariance techniques.

In some respects, the strengths of the present study might be perceived as the weaknesses of a more rigidly controlled study. In the present study, however, the external validity of the controlled delayed feedback research was of particular concern. The present study confirms the effectiveness and practicality of feedback based programs in "real world" settings.

Additional research regarding the generalizability of delayed feedback research to other process-oriented subject areas should be advanced. Although computational mathematics is largely process in nature, the present study utilized a fairly well articulated instructional system. It is unclear whether or not academic subjects involving literature or creative writing are equally amenable to a systematized feedback approach.

An additional area for further research concerns the effects of systematized feedback on task-relevant student questioning. It is possible that systematized feedback increases the number of task-relevant questions due to the information available for student review. However, it is also possible that student questionning would be reduced as a function of the preciseness and task relevance of the information provided during systematized feedback. Such possibilities should be investigated.

In summary, feedback is of significant value when applied in a systemtic manner. The present study confirms the effectiveness and practicality of systematically applied feedback in natural classroom settings. Feedback programs should systematically include instructional content, feedback procedures that include both teachers and students, and provision for assuring compatability within the instructional setting.

References

English, R. A., & Kinzer, J. R. The effect of immediate and delayed feedback on the retention of subject matter. Psychology in the Schools, 1966, 3, 143-147.

Gilman, D. A. Comparison of several feedback methods for correcting errors by computer assisted instruction. Journal of Educational Psychology, 1969, 60, 503-508.

Kulhavy, R. W. Feedback in written instruction. Review of Educational Research, 1977, 47, 211-232.

Kulhavy, R. W., & Anderson, R. C. The delay retention effect with multiple choice tests. Journal of Educational Psychology, 1972, 63, 505-512.

More, A. J. Delay of feedback and the acquisition and retention of verbal materials in the classroom. Journal of Educational Psychology, 1969, 60, 339-342.

Newman, D. A., Williams, R. G., & Hiller, J. H. Delay of information feedback in an applied setting: Effects on initially learned and unlearned items. Journal of Experimental Education, 1974, 42(4), 55-59.

Peek, J., & Tillema, H. H. Delay of feedback and retention of correct and incorrect responses. Journal of Experimental Education, 1979, 47, 171-178.

Sassenrath, J. M. Theory and results on feedback and retention. Journal of Educational Psychology, 1975, 67, 894-899.

Sturges, P. T. Verbal retention as a function of the informativeness and delay of information feedback. Journal of Educational Psychology, 1969, 60, 11-14.

Sturges, P. T. Information delay and retention: Effect of information in feedback and tests. Journal of Educational Psychology, 1972, 63, 32-34.(a)

Sturges, P. T. Effect of instructions and form of informative feedback on retention of meaningful material. Journal of Educational Psychology, 1972, 63, 99-102.(b)

Sturges, P. T., Sarafino, E. P., & Donaldson, P. L. Delay-retention effect and informative feedback. Journal of Experimental Psychology, 1968, 78, 357-358.

Surber, J. R., & Anderson, R. C. Delay-retention effect in natural classroom settings. Journal of Educational Psychology, 1975, 67, 170-173.

TITLE: Visual Perception in Language Learning:
A Developmental Perspective with Implications
For Second Language Learning and Research

AUTHORS: Roseanne Thomas Harrison

David T. Rickard

Visual Perception in Language Learning:

A Developmental Perspective with Implications for Second Language Learning and Research

Presented By

Roseanne Thomas Harrison
Dept. Of ESL
University of Hawaii

David T. Rickard
Specialist III in
Instructional Technology
Dept. of ESL
University of Hawaii

1980 AECT National Convention

Research and Theory Division
Denver, Colorado
April 22, 1980

Language or linguistic ability develops out of the acquisition of and the need to communicate meaning. The field of psycholinguisitics generally concerns itself with the acquisition of language. In studying the ontogeny of language psycholinguists have traditionally investigated the effect of the auditory mode to the exclusion of the visual. There are, however, researchers who are expanding the domain of psycholinguistics to include the semantic, pragmatic, paralinguistic, and nonlinguistic features of communication. (French, 1976) This type of research involves the integration of both auditory and visual perceptions in the development of meaning and language.

This presentation investigates the use of visuals in facilitating language ,learning. It has three sections. The first section looks at the effects of both visual and auditory perceptions on the ontogeny of language. The second section samples the growing body of research and data on the ways in which visuals facilitate first language learning. The third section discusses applications and implications of this research in second language research and in the second language classroom. In any study of visuals a distinction should be made between internally generated images (imagery or induced imagery), and externally generated images (pictures or imposed imagery). This study concentrates on externally generated or imposed images and uses the terms "pictures", "pictorials" or "visuals" synonomously.

1. Ontogeny of Language.

Current studies in the neurobiological foundations of language hold that the development of various language and perceptual skills must be preceded by maturation of the relevant areas of the brain.

For example, data on the ontogeny of speech indicate that the ability to vocalize is a function of muscular control over the organs of articulation which results from maturation of those areas of the brain which regulate these organs (Stark, 1978; Walsh and Diller, 1979) together with the ability to distinguish meaningful and non-meaningful sounds even before speech is possible. It has been suggested that this ability to integrate sound and meaning may be central to language learning (Dore, Franklin, Miller and Ramer, 1976). We believe that this interpretation is too restricted. Humans construct meaning from their perceptions and experience of their environment. These perceptions are visual and sensory as well as auditory. We would prefer to state that the integration of auditory and visual perceptions is central to the development of meaning which, in turn, is a prerequisite to the development of language. There appears to be a convergence of auditory discrimination, visual selectivity, and physical mobility or related activity at about the same time for the child. There are studies which demonstrate this thesis. For example, Reich cites this experience with his son. Initially, the child associated the auditory cue, "shoe", with the visual stimulus, the shoes on the shoe rack in his mother's closet but not those in his father's closet. Gradually over a period of time, he extended the cue to include shoes placed in his path, those in his father's closet, and finally shoes being worn. This began at about 8 months, well before the child began to verbalize. He would crawl to the closet and point to the rack. It would have been interesting to note at what point he would have attached the label to a pictorial stimulus as well.

Young children appear to conceptualize differently than do adults and their processes are not fully understood. (Howe, 1978; Rodgon, 1978; Duncan and Kellas, 1978). When they are constructing their meanings for language, the initial stages seem to be identification of the lexical item with the object or action (Clark and Sengul, 1978; Carter, 1975; Greenfield, 1978; Rodgon, etal 1977; Trevarthan, 1978). It is when they dissociate the lexicon from the object or action that adult-like language begins. This is considered the stage when "serious" language learning begins (Walsh and Diller, 1979) and occurs at about the age of two. Throughout this time, the auditory, visual and sensory modes of perception are being integrated in the development of meaning.

2. Use of Visuals in Teaching/Learning.

This section considers the role of visuals in enhancing comprehension and learning of older children and adults in formal classroom situations. The facilitative and deletrious effects of visuals have been widely investigated in areas such as vocabulary learning and concept formation and oral and written prose comprehension. These studies have been conducted looking at variables such as age, culture, socioeconomic status, content and task. In the following discussion we will focus on the use of visuals in concept formation, written prose comprehension (reading), and oral prose comprehension (listening).

2.1 Use of Visuals in Concept Formation.

Very often vocabulary learning involves acquiring the concepts which the lexical item represents. Numerous studies have been conducted on the use of visuals for vocabulary learning and their results have generally indicated facilitative effects. (See the works of Levin and his colleagues cited in the Bibliography). In another type of study visuals were used to help teach 3rd and 4th graders mathematical concepts (Tennyson, 1978). He found the picture condition enhanced his subjects' concept learning and rule learning. This use of visuals in content area learning seems to be a particularly fruitful area for further research.

2.2 Use of Visuals in Prose Comprehension.

This field of study has produced a variety of conflicting claims during its long history. Much discussion has centered on the merit of visuals used as textual accompaniments. We suggest that the problem has been in either the design of the visual, its expected role, the task being assessed, or the testing instrument. The visual should not be an alternative to the verbal text. It should function, rather, as an alternative source of information (Denburg, 1976-77). In this way it is an integral source of or element in textual redundancy. Redundancy is crucial in reducing ambiguity and enhancing comprehension. A well-executed visual, then, will enhance comprehension but will not deter the learner or recipient of the message from paying attention to the verbal text itself. The following sections will look at the effects of visuals on written prose (reading) and oral prose (listening) comprehension.

2.2.1 Use of Visuals in Reading.

In studies where the content, design, and test questions have been carefully controlled, the use of visuals has generally produced facilitative or positive results. (See, for example, Denburg, 1976-77). Haring and Fry (1979) analyzed a text for propositional content. They then designed two sets of visuals: one set was totally redundant with the upper level (or main idea) content of their test discourse; and one set was redundant with both upper and lower levels (main ideas and details). For their sixth grade subjects pictures enhanced recall of top level information, and the pictorial effects were both immediate and delayed. Comprehension was measured by recall of propositional content.

2.2.2 Use of Visuals in Listening.

In these studies the measure of comprehension is usually free or probed recall of meaning, or verbatim recall of surface structure forms. It is our feeling that recall of meaning or propositional content is, generally, a more valid measure of comprehension. Thus, most of the studies cited deal with the use of visuals in oral prose comprehension as measured by recall. Rohwer and Matz (1975) tested black and white children with oral text accompanied by either pictures or printed text and found that the picture condition significantly improved aural comprehension. Guttmann, etal (1977) investigating the degree of pictorial support needed, found that their subjects benefitted from partial pictures in recalling oral prose. Bates, etal (1978) used videotaped recordings of soap operas to test comprehension of anaphora. They found that the addition of the visual mode significantly enhanced comprehension among their college adult subjects. They also incidently found surprising verbatim recall of surface structure forms, a finding which has implications for L2 learning to be discussed below.

3. Visuals in Second Language Research and Teaching.

Proficiency or facility in a second language (L2) also results from the need to communicate meaningfully, and develops through comprehension and the acquisition of meaning. L2 learning, however, differs from L1 acquisition in that the L2 learner already has a storehouse of background knowledge and experience combined with proficiency in his/her L1 which ensure successful communication. L2 teaching should build upon this already acquired foundation and use it as the basis for successful L2 communication.

The functions of L2 teaching are two-fold: a) to teach new concepts or expand those already acquired using the target language (L2) as the medium of communication; and b) to teach or provide the language necessary to enable the learner to encode and communicate these concepts. In language teaching it is convenient to define requisite linguistic abilities in terms of receptive and productive skills. Receptive skills include listening and reading and have as their ultimate goal the accession of meaning. We suggest that they have the same psycholinguistic thinking base. Productive skills include speaking and writing and their goal is the communication of meaning. They also share a similar psycholinguistic base. As demonstrated above, visuals are highly appropriate for teaching such receptive skills as reading and listening as well as concept formation in the L1. This is also true for L2 learning/teaching. Additionally, the visual mode is uniquely suited for enhancing acquisition of productive skills. Which skill being taught has implications in the design and use of the visuals. Here, we will make a distinction between natural and naturalistic situations in materials design. Any "slice of life" taken out of context becomes contrived. Thus, it is theoretically impossible to have a completely natural situation in designed instructional materials. What can be supplied, however, is a naturalistic situation. In other words, the context or situation should be carefully designed for optimum learning/teaching to take place, and this will not detract from the goal of natural, holistic or spontaneous discourse or contexts. Visualization can provide this type of situation. The section following will focus on the integration of visual modes in teaching productive skills or communicative competence; that is, in providing the language necessary to enable the learner to communicate successfully in the target language (L2).

3.1 Visuals and Communicative Competence.

Communicative competence traditionally refers to a speaker's ability to use the form of language appropriate to the given context or situation. At this oral level the notion has been extended to include such features of the speech act as intonation, stress, register, gestures, and facial expressions as well as correct syntax and lexicon. In our research we have further expanded the traditional definition of communicative competence to include written as well as oral linguistic production or communication. Our studies indicate that modes of presentation which integrate the visual medium are particularly effective in teaching/learning communicative competence. There has been, to our knowledge, very little controlled investigation in this area. Our work, therefare is highly experimental in nature, and we believe that the results ore very promising for future research and classroom applications.

3.2 Demonstrations and Discussion.

The first task we will investigate is the use of visuals in teaching L2 vocabulary or linguistic forms to express concepts already acquired or to expand that class of concepts. Our long-range objective is to involve the learners in their own learning experiences. By engaging their active participation, their self-conscious use of language will be suspended and the need for communication will be foremost. In this way the visuals function as attitude vitalizers. One format we use is the "cloze" picture. The term is an extension of that used in reading verbal text. In designing the visual some obvious element is omitted. It is essential that this omission be infereable from the context and depending on the cultural and educational backgrounds of the learner.

3.2.1 Single Slides or Pictures.

(Show #1 here as an exercise to audience to demonstrate how it works. Note their reactions--active participation, especially.)

Discussion :

Objectives:

To get students talking in a natural but controlled situation.

To obtain spontaneous speech samples for recording and subsequent analysis to determine global communication errors.

Audience:

Any level of proficiency--beginners to advanced.

Advantages:

Causes students to do a considerable amount of logical reasoning, testing hypotheses and rejecting those which do not "fit" the context supplied.

Provides a situation for natural dialog in the classroom allowing analysis of speech and teaching of appropriate para- and non-linguistic features.

Provides a situaton for writing a paragraph or short essay based on classroom discussion. This allows teacher to determine type of errors transferred from speech to writing. It also give students source material for written tasks, thereby allowing indvidual cultural biases a legitimate expression.

Results:

The oral classroom discussion was taped and students profited from the playback. They could self-correct or peer-correct many grammatical errors. Unknown lexical items were supplied by teacher and their uses and semantic domains were discussed in a naturaliistic situation.

3.2.2 Sequences of Slides or Pictures.

Objectives:

Aids students in learning to organize information sequentially according to accepted rhetorical style.

They learn to make appropriate transitions between thoughts or written paragraphs.

They learn to develop coherence and unity in longer stretches of discourse.

Audience:

Intermediate or advanced learners--some degree of proficiency is required.

Advantages:

It is important to note that these situations are controlled by the context supplied. This allows the teacher to retain control over the linguistic forms and functions taught/used.

Results:

Note inclusion of a cloze picture in the sequence. This alowed students to digress and inject some of their own individuality into the discussion/assignment. It also provided an additional context for logical reasoning and thinking.

Possible Variations:

Photographs, magazine pictures, or any other type of flat picture can be substituted for slides.

3.2.5 Teaching/Modeling Oral Communicative Competence.

Objectives:

To teach oral communicative competence including para- and non-linguistic features of the speech event.

Audience:

All levels--beginners through advanced.

Materials:

A) Movies, videotapes: ideal for any level; especially useful in provding most complete modeling of all features of the communicative event.

B) Slide/tape: allow for more inferencing of para- and non-linguistic features; seem especially good for intermediate and advanced learners.

C) Flat pictures: most appropriate for advanced learners since they require the greatest amount of inferencing of all features of the speech act.

Note that the uses suggested above for the different types of visuals are under ideal conditions. In actual classroom use availability of both hardware and software may dictate other uses.

Possible Variations:

Play through once with both sound and visual media on. Turn off sound and run through visuals only. Have students role-play in the situations provided. If a segment is shown, students can improvise preceding and following segments.

Play sound only. Students can perform the actions. This gives practice in the non-linguistic features of a speech act. It also provides reinforcement of surface forms through repetition within a meaningful context.

3.2.4 Slides with Subtitles.

This demonstrates a somewhat different approach. It can be accompanied by a sound which emphasizes the grammatical structures being modeled. This provides an alternative mode of presentation of information which provides crucial redundancy of task in a naturalistic context. In other words, students are exposed to a flow of language with emphasis on certain grammatical forms.

3.2.5 Other Points for Discussion.

Teacher should

a) have objective clearly defined before choosing or designing the content of the visual and other modes of presentation to be integrated with the visual mode;

b) be aware of cultural or ethnic backgrounds of the students and their levels of proficiency in order to determine what conceptual constants are common or universal across cultures represented;

c) be aware of the distinction between natural, naturalistic and contrived situations.

3.2.6 Design of Visual.

The following points should be considered in designing visuals for L2 or cross-cultural teaching/learning:

cultural background of students

educational background or level of students

linguistic needs of the students

best way to present the specified objectives to the group of students in question considering these points.

Since most classroom situations include students from a variety of cultural backgrounds, the materials designer or teacher should consider what elements are constant or universal across various groups for a given concept or teaching task.

BIBLIOGRAPHY

Arlin, Marshall, Mary Scott and Janet Webster. 1979. The effect of pictures on the rate of learning of sight words: a critique of the focal attention hypothesis. Reading Research Quarterly 14:645-660.

Bates, Elizabeth, Laura Benigni, Inge Bertherton, Luigi Camaioni and Virginia Volterra. 1977. From gestures to the first word: on cognitive and social prerequisites. In Lewis, Michael and Leonard A. Rosenblum (Editors). Interaction, conversation and the development of language. New York: John Wiley and Sons.

Bialystok, Ellen and Joan Howard. 1979. Inferencing as an aspect of Cloze test performance. Working Papers in Bilingualism 17:26-36.

Boyd, Melba Joyce. 1979. Visual perception and the teaching of English. Unpublished A.D. dissertation, The University of Michigan. DAI 40:638A.

Carter, Anne L. 1975. The transformation of sensorimotor morphemes into words: a case study of the development of "more" and "mine". Journal of Child Language 2:233-250.

Clark, Eve and C. J. Sengul. 1978. Strategies in the acquisition of deixis. Journal of Child Language 5:457-5

Cohen, Leslie B. and Philip Salatapek. 1975. Infant perception: from sensation to cognition. New York: Academic Press.

Cole, Leo R. 1976. Relationships between the visual presentations and linguistic items in second-language teaching. IRAL 14:339-350.

Cole, Michael and Sylvia Scribner. 1974. Culture and thought. New York: John Wiley and Sons.

Denburg, Susan Dalfen. 1976-77. The interaction of pictures and print in reading instruction. Reading Reasearch Quarterly 12:176-189.

Dore, John, Margery B. Franklin, Robert T. Miller and Andrya L. H. Ramer. 1976. Transition phenomena in early language acquisition. Journal of Child Language 3:13-28.

Duncan, Edward M. and George Kellas. 1978. Developmental changes in the internal structure of semantic categories. Journal of Experimental Child Psychology 26:328-340.

Dunham, Trudy C. and Joel R. Levin. 1978. Strategies in reading comprehension: A. Imagery support and young children's prose learning. Working Paper No. 229. Wisconsin Research and Development Center for Cognitive Learning. Madison, Wisconsin: University of Wisconsin.

Durham, James Arthur. 1979. Relation of visual presentation to concrete and non-concrete learning tasks. Unpublished Ph.D. dissertation, University of Southern California. DAI 39:5274A.

French, P. L. 1976. Disintegrating theoretical linguistics and some future directions in psycholinguistics. In Carterette, Edward C. and Morton P. Friedman (Editors). Handbook of Perception. Volume VII: Language and Speech. New York: Academic Press. Pages 445-5

Greenfield, Patricia. 1978. How much is one word? Journal of Child Language 5:347-352.

Guttman, Joseph, Joel R. Levin and Michael Pressley. 1977. Pictures, partial pictures and oral prose learning. Journal of Educational Psychology 69:473-5

Halliday, M. A. K. 1978. Meaning and the construction of reality in early childhood. In Pick, Herbert L. Jr. and Elliott Saltzman (Editors). Modes of perceiving and processing information. New Jersey: Lawrence Erlbaum Associates.

Haring, Marilyn J. and Maurine A. Fry. 1979. Effect of pictures on children's comprehension of written text. ECTJ 27:185-190.

Higgins, Leslie C. 1978. A factor analytic study of children's picture interpretation behavior. ECTJ 26:215-232.

Hill, Harold H. 1978. Communication research and instructional technology. ECTJ 26:47-5

Hogaboam, Thomas W. and James W. Pelligrino. 1978. Hunting for individual differences in cognitive processes: verbal ability and semantic processing of pictures and words. Memory and Cognition 6:189-193.

Howe, Christine J. 1976. The meaning of two-word utterances in the speech of young children. Journal of Child Language 3:29-5

Inhelder, Barbel. 1978. Language and thought: some remarks on Chomsky and Piaget. Journal of Psycholinguistic Research 7:263-268.

Jahoda, Gustav, William M. Cheyne, Jan B. Deregowski, Durganand Sinha and Rachel Collingbourne. 1976. Utilization of pictorial information in classroom learning: a cross-cultural study. AVCR 24:295-315.

Jensen, Eva Dam and Thora Vinther. 1978. Video in foreign language teaching. System 6:25-29.

Kintsch, W. and Elizabeth Bates. 1977. Recognition memory for statements from a classroom lecture. Journal of Experimental Psychology: Human Learning and Memory 16:549-5

Laver, John. 1976. Language and nonverbal communication. In Carterette, Edward C. and Morton P. Friedman (Editors). Handbook of Perception. Volume VII: Language and Speech. New York: Academic Press. Pages 345-361.

Levin, Joel R. 1976. What we have learned about maximizing what children learn. In Levin, Joel R. and Vernon L. Allen (Editors). Cognitive learning in children: theories and strategies. New York: Academic Press.

Mangan, James. 1978. Cultural conventions of pictorial representation, iconic literacy and education. ECTJ 26:245-267.

McKirdy, Laura S. and Carolyn Kent Ronee. 1978. The efficacy of auditory and visual conjugate reinforcers in infant conditioning. Journal of Experimental Child Psychology 25:80-89.

Pressley, Michael. 1977. Imagery and children's learning: putting the picture in developmental perspective. Review of Educational Research 47:585-622.

Peeck, J. 1974. Retention of pictorial and verbal content of a text with illustrations. Journal of Educational Psychology 66:880-888.

Reich, Peter A. 1976. The early acquisition of word meaning. Journal of Child Language 3:117-123.

Rodgon, Maris Monitz. 1977. Situation and meaning in one- and two-word utterances: observations on Howe's "The meaning of two-word utterances in the speech of young children." Journal of Child Language 4:111-114.

Rodgon, Maris Monitz, Wayne Jankowski and Lucias Alenskas. 1977. A multifunctional approach to single word usage. Journal of Child Language 4:23-5

Rohwer, William D. Jr. 1970. Images and pictures in children's learning. Psychological Bulletin 73:393-5

Rohwer, William D. Jr. and Robert D. Matz. 1975. Improving aural comprehension in white and black children: pictures vs print. Journal of Experimental Child Psychology 19:23-36.

Ruch, Michael D. and Joel R. Levin. 1977. Pictorial organization versus verbal repitition of children's prose: evidence for processing differences. AVCR 25:268-279.

Rosinski, Richard R., James W. Pelligrino and Alexander W. Siegal. 1977. Developmental changes in the semantic processing of words and pictures. Journal of Experimental Child Psychology 23:282-291.

Scott, Stephen Allen. 1979. Comparative linguistic processing, dichotic listening and cerebral specialization in Navajo and Anglo children. Unpublished Ed.D. dissertation, Northern Arizona University. DAI 40:1368A.

Snowman, Jack and Donald J. Cunningham. 1975. A comparison of pictorial and written adjunct aids in learning from text. Journal of Educational Psychology 67:307-311.

Stark, Rachel E. 1978. Features of infant sounds: the emergence of cooing. Journal of Child Language 5:379-390.

Tennyson, Robert D. 1978. Pictorial support and specific instructions as design variables for children's concept and rule learning. ECTJ 26:291-300.

Trevarthan, Colwyn. 1978. Modes of perceiving and modes of acting. In Pick, Herbert L. Jr. and Elliott Saltzman (Editors). Modes of perceiving and processing information. New Jersey: Lawrence Erlbaum Associates.

Walsh, Terence M. and Karl C. Diller. 1979. Neurolinguistic considerations on the optimum age for second language learning. Proceedings of the Berkeley Linguistics Society. Berkeley, California. February, 1979.

TITLE: The Effectiveness of Elaborate Visual Cueing and Reduced Step Size in Facilitating Student Achievement on Different Instructional Tasks

AUTHOR: Thomas J. Jennings, Jr.

THE EFFECTIVENESS OF ELABORATE VISUAL CUEING AND REDUCED STEP SIZE IN FACILITATING STUDENT ACHIEVEMENT ON DIFFERENT INSTRUCTIONAL TASKS

by

Thomas J. Jennings, Jr.
Director, Instructional Resources Center
Assistant Professor, Curriculum and Instruction
College of Education
Kent State University

1980 AECT Convention
Research and Theory Division
Denver, Colorado

The Effectiveness of Elaborate Visual Cueing and Reduced Step Size in Facilitating Student Achievement on Different Instructional Tasks

Introduction

Early research in visualized instruction subscribed to a conceptual framework which emphasized comparisons between different media types. While this approach has generated some useful information for the selection and utilization of media types, it has done little to develop a scientific base for improving the learning effectiveness of visual materials produced by instructional designers and teachers (Lumsdaine, 1960). A serious flaw in this approach is its failure to deal with visual instructional materials as combinations of distinct cues.

A more productive approach employs a conceptual framework in which research investigates the stimulus characteristics of visuals. Levie and Dickie (1973), in a state-of-the-art report, advocated research that ". . . specifies the relevant variables in terms of the attributes of media rather than in terms of the media themselves." They qualified this by adding, "Media attributes are properties of stimulus materials which are manifest in the physical parameters of media." (p. 860) Recent research efforts have moved in this direction by dealing with the stimulus characteristics of visuals in relation to specific educational tasks, (Dwyer, 1967, 1972; Trabasso and Bower, 1968; Berry, 1974; and Parkhurst, 1974).

The present study attempted to contribute to the conceptual base for visualized instruction by exploring two cueing strategies used in visuals. Specifically, its purpose was to investigate the effectiveness of elaborate visual cueing and reduced step size in facilitating student achievement on different instructional tasks.

The following hypotheses were proposed in an effort to generate information to assist designers of instructional visuals in selecting cueing techniques which are most effective for facilitating learning on specific educational tasks. This would represent design-by-knowledge rather than design-by-intuition.

H_1: The instructional treatments utilizing reduced step size will be superior to the larger step size treatments in terms of facilitating student achievement on the immediate and delayed criterion tasks.

H_2: The instructional treatments utilizing elaborate visual cueing will be superior to the simple visual cueing treatments in terms of facilitating student achievement on the immediate and delayed criterion tasks.

H_3: The instructional treatment combining reduced step size with elaborate visual cueing will be superior to all other treatments in facilitating student achievement on the immediate and delayed criterion tasks.

Presentation and Evaluation Materials

The instructional materials used to test the hypotheses proposed in this study were modifications of an instructional unit on the human heart developed by Dwyer (1965). Dwyer's materials were selected because they offered certain advantages for this study: (1) they were designed to explore the stimulus characteristics of visuals; (2) data were available for analysis from past studies in which the materials had been used; (3) subjects interacting with the materials were required to perform criterion tasks similar to those found in realistic learning situations;

and (4) the materials package included assessment tools possessing satisfactory realibilities (.81 - drawing test, .79 - identification test, .82 - terminology test, .76 - comprehension test, and .91 - total criterial test) using the Kuder-Richardson Formula 20 reliability coefficient, (Dwyer, 1972).

Dwyer's original instructional package was used, in part, as the basis for this study. The 2,000-word script, terminology lables, and criterial measures were all retained intact. Modified versions of the black and white, simple-line-drawing sequence served as the primary presentation mode in this study. Modifications were made to further this study's investigation and they occurred as the result of a task analysis performed on previous research results obtained from a study conducted by Dwyer (1971). Utilizing the task analysis, four instructional treatments were designed and produced to test the hypotheses of this study.

Experimental Treatments

Group	Treatments
I	Larger step size (37 visuals), simple visual cueing (static position indicators).
II	Larger step size (37 visuals), elaborate visual cueing (dynamic - process arrows, motion indicators, and shading).
III	Reduced step size (47 visuals), simple visual cueing (static position indicators).
IV	Reduced step size (47 visuals), elaborate visual cueing (dynamic - process arrows, motion indicators, and shading).

Each treatment consisted of an instructional booklet describing the human heart, its parts, and the internal processes occurring during the systolic and diastolic phases. Contained within each booklet was the 2,000-word instructional heart script accompanied by appropriate visuals of the heart. The booklets were divided into individual pages (or frames). Each page of the booklet consisted of an 8 1/2 x 11 inch sheet of white paper; occupying the top portion of the page was a 4 x 5 inch simple black-line drawing of the heart. Corresponding paragraphs of the instructional script were positioned on the lower portion of the page beneath the heart picture. Each illustration of the heart was labeled with appropriate terminology. It should be noted that interspersed review questions were not employed in the instructional treatment of this study since it was feared that they would have an equalizing effect on the experimental treatments. All treatments contained the same instructional script and printed terminology labels; they differed only in cueing strategies used.

Experimental Procedures

The sample population for this study consisted of 92 university students enrolled in The Pennsylvania State University. These subjects were volunteers obtained from two introductory university courses - Instructional Media 411 and Educational Psychology 14. For participation in this study, and as a motivational device, all subjects received extra credit in their respective courses. Each subject was required to attend two experimental sessions. During Session I, subjects were randomly assigned to one of the four treatment groups - resulting in an n = 23 for each treatment group.

In Session I, subjects interacted with their assigned instructional presentations and completed four criterial tests. Before treatments were begun, subjects were arranged in separate treatment groups and told to read the directions on the cover of the instructional booklet. All subjects received the same directions. The printed information consisted of three points: (1) subjects were told that the purpose of the study was to investigate the effectiveness of visual illustrations and cueing strategies; (2) subjects were told that there was no time limit and that they, therefore, should progress at their own pace through the booklet (self-pacing; and (3) subjects would be tested on a battery of criterial tests immediately after completing the booklet. Subjects were also told verbally that they would be retested six weeks later in Session II. The subjects then interacted with their respective instructional booklets on an individual and self-paced basis. Although no time limit was imposed, subjects were timed so that efficiency scores could be computed later. Upon completion of the treatment, each subject was asked to take the drawing, identification, terminology, and comprehension tests. Subjects were permitted to take as much time as needed for each criterion test before proceeding to the next. Session II occurred six weeks later; the four criterial tests were retaken by subjects to measure delayed retention. All responses were recorded on optical scan answer sheets, except for the drawing test which required subjects to draw and label a representation of the heart directly on the test surface. Drawing tests were scored by an independent evaluator and forwarded for statistical analysis. All data were analyzed by analysis of variance techniques to determine if statistically significant differences existed among instructional treatments.

Statistical Analysis

The first part of the statistical analysis examined both criterion test reliabilities (K-R 20) and homogeneity of variance among treatment groups (Bartlett's Test).

Following this, interpretation of the study's findings was accomplished by a randomized factorial design. Specifically, a three-factor, repeated-measure design was used with two between-subjects factors (A and B) and one within-subjects factor (C). In notation form, the design can be characterized as (A_2 @ B_2) in C_2, indicating two levels of factor A crossed with two levels of factor B, and both A and B nested in factor C. The independent variable in the study was the method of visual cueing used, while the dependent variables were test scores on the drawing, identification, terminology, comprehension, and total criterial tests.

Factors in Experimental Design

Between-Subjects Factors	
Factor A:	Step Size
	Level A_1 (Larger Step Size)
	Level A_2 (Reduced Step Size)
Factor B:	Cueing Technique
	Level B_1 (Simple Visual Cueing)
	Level B_2 (Elaborate Visual Cueing)
Within-Subjects Factors	
Factor C:	Time/Test Administration
	Level C_1 (Immediate Testing)
	Level C_2 (Delayed Testing)

A three-way analysis of variance (ANOVR) was conducted on the number of correct responses achieved by subjects on each criterion test, as well as on their combined total criterion score. An F-ratio with a p value of .05 significance level or less was considered sufficient to reject null hypotheses and to verify alternative hypotheses. An additional two-way analysis of variance (ANOVES) was performed separately on the immediate and delayed retention measures to reveal any significant findings obscured by collapsing data on the within-subjects factor of the three-way analysis of variance. Efficienty scores were calculated for each treatment group and analyzed by analysis of variance (ANOVES) techniques to determine if significant statistical differences existed.

Results

Criterion test reliabilities were obtained by calculating Kuder-Richardson Formula 20 reliability coefficients; the values obtained for the criterion tests were all of a satisfactory level (Drawing Test, .842; Identification Test, .854; Terminology Test, .868; and Comprehension Test, .789). Results from Bartlett's Test for homogeneity of variance conducted on the dependent variables (the criterion tests) were all non-significant at the .05 level, indicating that the subjects who received the instructional treatments could be viewed as having been drawn randomly from populations with common variance.

The analysis of variance procedures performed on the data resulted in either support or lack of support for the research hypotheses. The following table indicated the specific decisions made regarding each research hypothesis.

Decisions Regarding Research Hypotheses

Research Hypotheses	Criterion Measures Drawing	Identification	Terminology	Comprehension	Total Test
H_1	Supported	Not Supported	Not Supported	Not Supported	Supported (Immediate Retention)
H_2	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
H_3	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported

Based upon the data obtained in the statistical analyses of this study, the following findings were made in regard to the design of visualized learning materials.

Relative to the step size of visuals within a self-paced visualized instructional sequence, it was found that:

1. Instructional treatments containing identical printed scripts and word labels, but employing different visual step sizes, were not equally effective in facilitating student achievement on certain criterion tasks.
2. In the immediate retention condition, those instructional treatments employing selective reduction of visual step size had an overall facilitative effect on learning as evidenced by

the significant F-ratio of 4.098 (.05 level) for reduced step size treatments on the total criterion test measure. On individual criterion tasks, selectively reduced visual step size treatments had a facilitative learning effect on drawing (significant F-ratio of 5.062 at .05 level) but not on comprehension, identification, or terminology.

3. In the delayed retention condition, those instructional treatments employing selective reduction of visual step size had little facilitative effect on the criterion tasks. The overall learning effect present in the immediate retention condition did not occur in the delayed retention condition. Of the individual criterion tasks, only drawing appeared to be positively affected by selectively reducing visual step size.

Relative to elaborate visual cueing within a self-paced, visualized instructional sequence, it was found that:

1. Instructional treatments containing identical printed scripts and word labels, but differing in degree of visual cueing elaborateness present, were equally effective in facilitating student achievement on the criterion tasks (drawing, identification, terminology, and comprehension).
2. No advantage was gained in a visualized instructional sequence by utilizing elaborate visual cueing.

Relative to the interaction of selectively-reduced, visual step size and elaborate visual cueing within a self-paced, visualized instructional sequence, it was found that:

1. No statistically significant facilitative effect was achieved by combining these elements within a visualized instructional sequence.
2. An examination of treatment group means revealed, however, that in almost all instances, Group IV (combined treatment) means were higher than those of other treatment groups.

Relative to the efficiency of the instructional treatments included in this study, it was found that:

1. In terms of time spent on the instructional treatments, no statistically significant differences existed among the four experimental groups. It is important to note that selectively reducing visual step size (and thus increasing the number of visuals utilized) did not increase the time needed by subjects to interact with the learning materials.
2. None of the experimental treatments were significantly more efficient than others in facilitating student achievement on the criterion tasks.

BIBLIOGRAPHY

Berry, L. H. An Exploratory Study of the Relative Effectiveness of Realistic and Non-Realistic Color in Visual Instructional Material. Unpublished Doctoral Dissertation: The Pennsylvania State University, 1974.

Dwyer, F. M. An Experimental Evaluation of the Relative Effectiveness of Selected Visual Illustrations in Teaching Science Concepts to College Freshmen. Unpublished Doctoral Dissertation: The Pennsylvania State University, 1965.

Dwyer, F. M. "Adapting Visual Illustrations for Effective Learning." Harvard Educational Review, 1967, 37, pp. 250-263.

Dwyer, F. M. "Effect of Knowledge of Objectives on Visualized Instruction." The Journal of Psychology, 1971, 77, pp. 219-221.

Dwyer, F. M. A Guide for Improving Visualized Instruction. State College, Pennsylvania, 1972.

Levie, W. H. and K. E. Dickie. "The Analysis and Application of Media." In R. M. W. Travers (Ed.), The Second Handbook of Research on Teaching. Chicago: Rand McNally, 1973.

Lumsdaine, A. A. "Graphic Aids, Models, and Mockups as Tools for Individual and Classroom Instruction." In G. Finch (Ed.), Educational and Training Media: A Symposium, Washington, D. C.: National Academy of Science - National Research Council, Publ. No. 789, 1960, pp. 69-113.

Parkhurst, P. E. Assessing the Effectiveness of Self-Paced Visualized Instruction: A Multifactor Analysis on Five Different Educational Tasks. Unpublished Doctoral Dissertation: The Pennsylvania State University, 1974.

Trabasso, T. and G. H. Bower. Attention in Learning: Theory and Research. New York: John Wiley, 1968.

TITLE: Cognitive Style Predictors of Performance

AUTHOR: David Jonassen

COGNITIVE STYLE PREDICTORS OF PERFORMANCE

The application of the trait-treatment research methodology to instructional design procedures has been perationalized by the matching model of instruction . This approach seeks to link specific treatment components to unctional characteristics of learners in order to correct or compensate for deficiencies, capitalize on strengths, or challenge the learner (Messick, 1974). While a large body of literature supports the validity of such an approach, results to date hve been inconsistent. Matching students and teachers based on similarities in their cognitive styles (McAdam, 1971) produced increases in educational development and reading level, with "matched" students expressing a more positive attitudes about their instructional activities than unmatched students. In another community college study, Frever (1975) successfully matched students with educational activities, resulting in higher course grades. On the other hand, Scerba's (1977) matching of learning styles with teaching styles produced no differences on any measure of student performance. Considering the difficulty and expense of matching students with teachers or preferred instructional activities, a strong rejection of matching procedures was suggested.

The efficacy of the matching model of instruction is partially predicated on establishing consistent relationships between cognitive and learning styles (traits) with achievement variables. Consistent with principles of aptitude-treatment interaction research, the temptation to generate generalizations about the predictive validity of cognitive styles must be resisted (Cronbach and Snow, 1977). The most extensively researched style, field dependence-independence, has failed to show any such relation to overall achievement measures anyway (Witkin, et al., 1977). Further, the potentiality of cognitive style variables as predictors of academic performance is overshadowed by firmly esablished relationships with mental ability (intellegence), level of motivation, and prior learning (cognitive structure). While traits measured by cognitive styles such as field dependence and conceptual style are independent of intellegence (Frehner, 1972), their relative contributions to variance on school performance measures are small when compared to I.Q. scores (Robinson and Gray, 1974). This study sought to determine the predictive relationships between several cognitive styles and different types of academic performance. While intellegence scores were unavailable and therefore not accounted for, intellegence seemed to emerge in the form of a stong factor generated by the analysis of data.

Cognitive Style Predictors

The present study considered the potential predictive contributions of several cognitive styles: field articulation, locus of control, and the educational cognitive styles as conceived by the Hill model. The latter consists of twenty-eight variables descibing the means by which individuals derive meaning from the environment -- symbolically, culturally, and inferentially.

The research base is best established for field dependence-independence, the perceptual and intellectual skill of extracting information from its surroundi field. Field independent subjects are not as affected by contextual information, are better able to impose their own structure on information and are generally less socially interactive. Field independence is highly correlated to mathematical skills and a predilection for math/science instruction (Feij, 1976), concept learning (Rains and Meinke, 1976) and problem solving ability (Witkin, et al., 1977).

The educational cognitive styles were developed by Hill (1974) as part of the educational sciences, with the expressed purpose of guiding instructional decisions with regard to the styles of learners. If instruction were adjusted to fit students' educational cognitive styles, then mastery learning by almost all stuents would be possible. The potential of Hill's model remains questionable, due to lack of a consistent predictive relationship between style variables and academic performance. Mustachio (1977) found only a minor, post hoc relationship to achievement. Educational cognitive styles did not aid the teaching of disadvantaged (Berke, 1976), and only moderate concurrent validity was found between styles and achievement in lower class students (London, 1975). In a large community college and university study, the American College Testing Program (1977) mapped students and individualized programs to accommodate styles, finding no significant relationships between educational cognitive styles and learning outcomes. The future of these cognitive style variables in addition to the matching model of learning is predicated on establishing consistent relationships between cognitive styles and various types of performance. Without such support, these constructs will devolve into obscurity like so many other educational panaceas.

Method

A total of 70 students were enrolled in 3 sections of an introductory instructional media course at a southeastern university. The sample included upper level under raduate and graduate students completing degrees in a variety of majors. It should be noted that the sample was predominately female. Because of attrition and record keeping problems, complete data were available for only 56 students. During the initial class session, students were administered a selection of personality and cognitive style instruments.

Instrumentation

Rotter's Internal-External Scale (Rotter, 1966) is a 29-item (six fillers), forced-choice test which assesses degree of internnality or externality. Respondents are expected to choose between two statements which they generally feel or believe is true. Larger scores represent higher levels of externality.

The Hidden Figures Test (French, Ekstrom, ad Price, 1963) measures field articulation. It is designed to test an individual's ability to locate simple, irregular figures embedded in more complex stimulus patterns. It has been correlated (r=.63) with Witkin's Embedded Figures Test (Jackson, Messick and Myers, 1964). It consists of 32 complex black-and-white, geometric figures. Subjects are instructed to identify, in multiple-choice fashion, which of five simple figures are hidden in each complex stimulus item.

Educational Cognitive Style Inventory is the test battery developed at Oakland Community College (Michigan) to determine the educational cognitive style of individuals. As a part of the Eductional Sciences (Hill, 1974), this instrument seeks to empirically map an individual's mode of behavior in searching for meaning. An individual's eductional cognitive style is comprised of the Cartesian product of sets of information: symbols and their meaning, cultural determinants of the meaning of symbols, modalities of inference, and educational memory. The first three of these are measured by the Cognitive Style Interest Inventory; the last remains in the developmental stage.

Twenty-eight variables (see Table 1), each consisting of eight items in the inventory, are measured. These are forced-choice responses (rarely, sometimes or usually) to questions related to each style measured. Each response is weighted and summed for each variable. The ordering of questions is randomized to minimize response set.

Insert Table 1 about here

The independence of each of these variables has been questioned by Clark and Sheriff (1977). In conducting a factor analysis, they found a single major factor (eigenvalue= 8.0) and three other significant factors onto which the majority of variables loaded. A similar analysis, conducted as part of this study, indicated that all 28 variables were not in fact independent.

The dependent variables consisted of four major course requirements. Graphic production skills (SKILLS) comprised the total point score from the qualitative evaluation of several instructional materials produced by students such as transparencies, filmstrips, slides, and other graphics, adjusted for the number of attempts necessary to reach a predetermined criterion score. Performance required a combination of psychomotor ability, esthetic evaluation, artistic ability, and so on. The second variable was a recall type examination (FINAL) consisting of fifty objective questions measuring recall of facts, procedures, rules, and principles. The third measure consisted of a problem-solving activity (PRACTICUM) related to selection and evaluation, wherein students were required to select media appropriate to given instructional situations and rationalize their choices using principles of instruction and media utilization. Analysis and synthesis skills were involved in this task. The final variable consisted of development and implementation of a mediated teaching module (PROJECT). This required application of appropriate aspects of the first three variables. A more detailed task analysis indicated the first three requirements were relatively independent.

Results

A stepwise regression analysis, using the .50 significance level as the entry criterion, was conducted for each of the variables (see Table 2). For the SKILLS variable, field independence emerged as the strongest predictor, with qualitative esthetics as an understandable secondary predictor. The negative relationship of qualitative code histrionics to performance was probably due to the very specific criteria used to evaluate the graphics projects. Students were aware of these ahead of time and worked to achieve prespecified levels of performance. These independent variables accounted for over one fourth of the variance in skills scores.

Insert Table 2 about here

The FINAL variable produced some strong, albeit confusing predictors. The negative relationship of qualitative code histrionics to exam performance is reasonable considering the factual and purposive nature of this variable. The negative predictive relationship between the qualitative visual mode of perception and exam scores is understandable only in terms of the variety of modes through which information is acquired in such a course; the primary nature of the task is linguistic. Qualitative code proxemics as a strong positive predictor (accounting for over 10% of the variance) would seem artifactual, unless some other trait was actually being measured by this variable. In subsequent factor analysis, the second strongest factor (eigenvalue = 2.75) was dominated by this variable. It was correlated with the auditory, synnoetics, and family variables, support the interpersonal communicative interpretation.

The PRACTICUM variable was predicted by the positive influences of qualitative code auditory, the cultural determinant individual, and the deductive reasoning variable, with negative relationships to the magnitude and appraisal inference variables. These relationships are accurately descriptive of the nature of this task, the integration of information acquired through lectures, applied to a problem solving task requiring reasoned inference, with a deemphasis on categorical modes of thinking. The effects of the predictive variables were stronger than for any of the other dependent variables ($R^2 = .438$).

The PROJECT variable scores were predicted by the positive influences of field independence, individuality, and kinesics, all of which are pertinent to the development and presentation of a lesson. The cultural determinant individuality implied by each presentation is consistent with the negative relationship of ethics or group value orientation. Teaching or presentions before a group are personal statements. Students evidently felt no need to role-play or attempt to meet group expectations, as indicated by the negative b value for histrionics.

In an effort to reduce the number of predictor variables, all thirty-one independent variables were factor analyzed. The factor matrix was rotated to varimax criterion (see Table 3). A total of the factors emerged (eigenvalue 1.0), indicating the lack of independence of all 31 variables. The factor structure tht emerged was similar to

---

Insert Table 3 about here

---

at generated BY Clark and Sheriff (1977). Factor scores for each individual were calculated. These factor scores were then entered into a stepwise regression analysis, again using the .50 significance level as entry criterion (see Table 4). For each dependent variable, the same factor, with loadings for field independence and deductive reasoning, was entered into the regression equations. For the SKILLS and PROJECT variable, this was the only factor entered. Though intellegence data were unavailable for this study, this factor may be found to be highly correlated with general mental ability. For the FINAL variable, an additional factor,

---

Insert Table 4 about here

---

lated to psychomotor ability, was entered with a negative b value, indicating a strong negative relationship between psychomotor and final exam performance. For the PRACTICUM variable, one other factor was also entered into the regression equation. An emphasis on spoken language vis a vis written language was found to have a negative predictive relationship to performance on this written exercise. Both of these additional factors were readily understandable in terms of the task requirements of each of the dependent variables.

Discussion

The varied nature of performances measured by this course were predicted by a commensurate variation of cognitive styles.

The overlap in cognitive, perceptual, and affective requirements in those tasks is reflected in the duplication of some independent variables. Students enrolled in this course seemingly did not perceive a need to play a role or perform for others. This is due perhaps to the production orientation of the course, and the individuality implied by that product development. The emphasis on the role of media in communication diverting attention from the role of the individual as performer may also have contributed to this effect. The perceptual implications of field independence seemed more important than the reasoning influences, as it impacted more on perceptually related tasks. However, the distillation of the data through factor analysis appeared to reverse this emphasis. The potential of cognitive styles as predictors of learning performance received considerable support. Unlike other studies, styles accounted for a very substantial proportion of the variance (in most cases, over 40%).

While the preeminence of intellegence as the primary predictor of achievement was not proven by this study, it was suggested by the consistent emergence of a single factor that relates strongly to reasoning and inferential ability. The deductive modality of inference, coupled with field independence, would suggest intellectual ability rather than creativity, both of which would be valuable capabilities in such a course.

It is suggested that a similar study, accounting for mental ability, motivation, prior learning, as well as cognitive style be undertaken to establish relative importance of all of these varables. The use of cognitive styles for instructional design is predicated on establishing aptitude-treatment interactions on specific tasks. This study only indicates the relative importance of cognitive styles as predictors but made no attempt to make hypothetical predictions about how they would relate to types of treatment. Considerable research in this area is still needed to clarify the relationship of instructional, individual and task-related variables.

REFERENCES

American College Testing Program. Promoting student learning in college by adaptiung to individual differences in educational cognitive style, Final Evaluation Report. Iowa City, Iowa: American College Testing Program, 1977. (ED 158 699)

Berke, G.B. Employing educational cognitive style as a teaching aid for educationally disadvantaged college students. Dissertation Abstracts International, 1976, 37 (3A), 1461.

Chronbach, L.J. & Snow, R.E. Aptitudes and instructional methods. New York: Irvington, 1977.

Clark, F.E. & Sheriff, D.E. A factor analytic study of Hill's cognitive style inventory. Paper presented at the Annual Convention of the Association for Educational Communbications and Technology, Miami, Florida, April, 1977.

Feij, J.A. Field independence , impulsiveness, high school training and academic achievement. Journal of Educational Psychology, 1976, 68, 793-799.

Frehener, V.L. Cognitive style as a determinant of educational achievement among sixth grade elementary students. Unpublished doctoral dissertation, Utah State University, 1972.

French, J. W., Ekstrom, R.B., & Price, L.A. Manual for the kit of reference tests for cognitive factors. Princeton, N.J.:Educational Testing Service, 1963.

Frever, W.E. An exploratory study of prescriptive instruction in social science employing educational cognitve styles and systemic analysis. Unpublished docatoral dissertation, Wayne State University, 1975.

Hill, J.E. *The educational sciences*. Bloomfield Hills, Mich.:Oakland Community College Press, 1974.

Jackson, D.N., Messick, S., & Myers, C.T. Evaluation of group and individual forms of embedded figures, measures of field dependence. *Educational and Psychological Measurement*, 1964, 24, 177-192.

London, D.T. Concurrent validity of Hill's cognitive style model as a prototype for successful academic programs among lower class students. Unpublished doctoral dissertation, Pennsylvania State University, 1975.

McAdam, G.F. Personalizing instruction through the educational science of cognitive style and teaching style. Unpublished doctoral dissertation, Wayne State University, 1971.

Messick, S. Personal styles and educational options. In S. Messick & Associates (Eds.), *Individuality in Learning*, San Francisco, Cal.:Jossey-Bass, 1974.

Mustachio, J.A. The influence of specific counseling and classroom applications of educational cognitive style on community college students' self-concepts and grade achievements. *Dissertation Abstracts International*, 1977, *34* (3A), 1256.

Rains, M.J. & Meinke, D.L. Effects of cognitive style, group structure, instructions, and training sequence upon acquisition and transfer in concept attainment. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, Cal., April 19-23, 1976.

Robinson, J. E. & Gray, J.L. Cognitive style as a variable in school learning. *Journal of Educational Psychology*, 1974, *66*, 793-799.

Rotter, J.B. Generalized expectancies for internal vs. external locus of control of reinforcement. *Psychological Monographs*, 1966, 80, No. 1 (Whole No. 609).

Scerba, J.R. Compatability of teaching strategies and learning styles as a determinant of academic success. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, Cal., April 8-12, 1979.

Witkin, H.A., Moore, C.A., Goodenough, D,R., & Cox, P.W. Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 1977, 47, 1-64.

TABLE 1

Educational Cognitive Style Variables

SYMBOLS AND THEIR MEANINGS

Theoretical Orientation to Symbols:

1.	T(AL)	Theoretical Auditory Linguistics. Finding meaning through words you hear.
2.	T(AQ)	Theoretical Auditory Quantitative. Finding meaning in spoken numerical symbols, relationships, and measurements.
3.	T(VL)	Theoretical Visual Linguistics. Finding meaning from words you see.
4.	T(VQ)	Theoretical Visual Quantitative. Finding meaning in numerical symbols, relationships, and measurements you see.

Qualitative Orientation to Symbols:

5.	Q(A)	Qualitative Auditory. Perceiving meaning through the sense of hearing. A major in this area indicates ability to distinguish between sounds, tones of music, and other purely sonic sensations.
6.	Q(O)	Qualitative Olfactory. Perceiving meaning through the sense of smell.
7.	Q(S)	Qualitative Savory. Perceiving meaning by the sense of taste. Chefs should have highly developed qualitative olfactory and savory abilities.
8.	Q(T)	Qualitative Tactile. Perceiving meaning by the sense of touch, temperature, and pain.
9.	Q(V)	Qualitative Visual. Perceiving meaning through sight.
10.	Q(P)	Qualitative Code Proprioceptive or sometimes called the sixth sense, synthesizing or combining a number of associated symbols into a performance of a task; e.g., typewriting, playing a musical instrument.
11.	Q(CEM)	Qualitative Code Empathetic. Sensitivity to the feelings of others, ability to put yourself in another person's place and see things from his point of view.
12.	Q(CES)	Qualitative Code Esthetic. Enjoying the beauty of an object or an idea. Beauty in surroundings or a well-turned phrase are appreciated by a person possessing a major strength in this area.

13.	Q(CET)	Qualitative Code Ethic. Commitment to a set of values, a group of principles, obligations and/or duties. This commitment need not imply morality. Both a priest and a criminal may be committed to a set of values although the "values" may be decidedly different.
14.	Q(CH)	Qualitative Code Histrionic. Exhibiting a deliberate behavior or "playing a role: to produce some particular effect on other persons. This type of person knows how to fulfill role expectations.
15.	Q(CK)	Qualitative Code Kinesics. Understanding and communicating by non-linguistic functions such as facial expressions and motions of the body (e.g., smiles and gestures).
16.	Q(CKH)	Qualitative Code Kinesthetic. Performing motor skills according to a recommended, or acceptable, from (e.g., bowling according to form, or golfing).
17.	Q(CP)	Qualitative Code Proxemics. Judging the physical and social distance that the other person would permit, between oneself and that other person.
18.	Q(CS)	Qualitative Code Synnoetics. Personal knowledge of oneself.
19.	Q(CT)	Qualitative Code Transactional. Maintaining a positive communicative interaction which significantly influences the goals of the persons involved in that interaction (e.g., salesmanship).
20.	Q(CTM)	Qualitative Code Temporal. Responding or behaving according to time expectations imposed on an activity by members in the role-set associated with that activity.

CULTURAL DETERMINANTS OF THE MEANINGS OF SYMBOLS

21.	A	Represents Associates. A major degree of influence by friends or persons other than family.
22.	F	Indicates a major Family influence. The family influence might include immediate family, church or special authority figures.
23.	I	Stands for Individual. An "I" in the major column indicates significant independence in decision making.

MODALITIES OF INFERENCE

24.	M	Magnitude. A form of "categorical reasoning" that utilizes classifications or rules as the basis for accepting or rejecting an advanced hypothesis. Persons who need to define things or know the "policy" in order to understand them reflect this modality.

25. D Difference. This pattern suggests a tendency to reason in terms of one-to-one contrasts or comparisons of selected characteristics or measurements, seeing things in terms of how they "differ." Artists often possess this modality as do creative writers and musicians.

26. R Relationship. This modality requires that things be seen in terms of how they are alike. People with this modality frequently say, "This is like that."

27. L Appraisal. The modality of inference employed by an individual who uses all three of the modalities noted above (M, D, and R), giving equal weight to each in his reasoning process. Individuals who employ this modality tend to analyze, question, or in effect, appraise that which is under consideration in the process of drawing a probability conclusion.

28. (K) Deductive. Indicates deductive reasoning, or the form of logical proof used in geometry or that employed in syllogistic reasoning.

TABLE 2

Summary of Stepwise Regression Analyses

(Significant Independent Variables)

Dependent Variable	Intercept	Independent Variables	b Value	Type II SS	F	R^2
SKILLS	183.41	Field Dependence	+0.37	424.63	7.96**	
		Qualitative Code: Esthetic	+0.66	327.80	6.15*	
		Qualitative Code: Histrionic	-0.53	421.96	7.91**	.277
FINAL	83.49	Qualitative Visual	-0.94	790.73	15.96***	
		Qualitative Code: Histrionic	-0.37	209.75	4.23*	
		Qualitative Code: Proxemics	+1.25	924.03	18.65***	.403
PRACTICUM	90.49	Qualitative Auditory	+0.69	469.66	10.34**	
		Individual	+0.70	306.76	6.75*	
		Magnitude	-1.55	1326.38	29.20***	
		Appraisal	-0.42	148.87	3.28	
		Deductive	+0.45	220.99	4.87*	.438
PROJECT	97.07	Field Dependence	+0.31	281.86	6.44*	
		Qualitative Code: Ethic	-0.62	288.53	6.59*	
		Qualitative Code: Histrionic	-0.61	483.57	11.04**	
		Qualitative Code: Kinesics	+0.49	214.44	4.90*	
		Individual	+0.82	428.36	9.78**	
		Magnitude	-0.64	210.96	4.82*	.431

* $p \leq .05$

** $p \leq .01$

*** $p < .001$

TABLE 3

Varinax Rotated Factor Pattern

Variable	Loading	Variable	Loading	Variable	Loading	Variable	Loading
FACTOR 1 (Reasoning)		**FACTOR 2 (Interpersonal Communication)**		**FACTOR 3 (Spoken Language)**		**FACTOR 4 (Psychomotor Performance)**	
Difference	.725	Auditory	.592	Auditory Linguistics	.810	Proprioceptive	.771
Relationship	.706	Proxemics	.791	Visual Linguistics	-.794	Kinesthetic	.847
Appraisal	.826	Synnoetics	.509			Histrionic	.463
Deductive	.510	Family	.593				
FACTOR 5 (Persuasiveness)		**FACTOR 6 (Symbolism)**		**FACTOR 7 (Self-Control)**		**FACTOR 8 (Visual/Haptic Style)**	
Synnoetics	.622	Visual Quantitative	.863	Locus of Control	.612	Tactile	.751
Transactional	.563	Histrionics	-.460	Temporal	.813	Visual	.453
Associate	-.695					Empathetic	-.471
Individual	.604						
FACTOR 9 (Inference)		**FACTOR 10 (Attendance to Nonverbal Cues)**					
Field Dependence	.834	Kinesics	.883				
Deductive	.519	Synnoetic	.435				
		Magnitude	.471				

TABLE 4

Stepwise Regression Analysis of Factors

Dependent Variable	Intercept	Factors Retained	b Value	Type II SS	F	R^2
SKILLS	198.31	Factor 9	+1.89	199.54	2.98	.055
FINAL	87.92	Factor 4	-2.98	468.65	8.31**	
		Factor 9	+2.30	269.24	4.78*	.239
PRACTICUM	83.80	Factor 3	-2.14	245.11	3.71	
		Factor 9	+2.03	231.06	3.50	.132
PROJECT	86.39	Factor 9	+2.26	272.82	4.25*	.077

* $p \leq .05$

** $p \leq .01$

TITLE: The Effect of Level of Knowledge of the Subject on the Instructional Effectiveness of Illustrations Which Integrate Abstract and Realistic Visualization

AUTHOR: John H. Joseph

The Effect of Level of Knowledge of the Subject on the Instructional Effectiveness of Illustrations Which Integrate Abstract and Realistic Visualization

John H. Joseph
The Pennsylvania State University
The Capitol Campus

Paper Presented at the 1980 Annual Convention
Association for Educational Communication and Technology
Research and Theory Division

Denver, Colorado April 23, 1980

Purpose

This study examines the effect of an entering behavior, specifically the level of general knowledge of the subject matter, on the instructional effectiveness of illustrations which integrate abstract and realistic visualization.

The relative effectiveness of abstract and realistic visualization has become a perennial issue. A general preference for realism is reinforced by several theorists. Dale's (1946) "Cone of Experience," Carpenter's (1953) "Sign Similarity Hypothesis," and Morris' (1946) "Iconicity Theory" are also supportive of the notion. The preference is also based partly on the affective value of realistic visuals. Findings of a general preference for complex detailed illustrations, particularly by older children and adults (French, 1952; Spaulding, 1955; Hanes, 1973) support this intuitive basis. Dember (1960), Yarbus (1967), Kahneman (1973), and Haber (1973) cite evidence that complexity is a major determinant of attention.

Other theorists (Broadbent, 1958, 1965; Travers, 1964, 1970; Dwyer, 1972) argue that an increase in realism will not necessarily lead to increased learning. These researchers feel that the irrelevant cues may interfere with learning. Travers (1964) advocates that the discarding of less important information and the retention of more important should be done for the learner to assure effectiveness (pp. 380-382). Hochberg suggests that "the characteristics of a given object may be communicated better as the representational fidelity of the surrogate deteriorates" (1962, p. 30). Dwyer (1972) found evidence to support this notion under certain conditions.

Dwyer found that the type of visual illustration (abstract vs realistic) which was most effective for instruction was dependent upon the type of information to be transmitted (or, the kind of objective), whether the instruction was self-paced or externally-paced, the grade level, and the level of entering behavior of the students (1972). The type of illustration most effective was also found to be dependent on the level of general ability (IQ) (1976). For certain educational objectives, Dwyer found no significant differences between verbal only and visualized treatments (1972).

Joseph (1978) found that the inclusion of realistic visualization improved instructional effectiveness under general conditions. The effectiveness of abstract visualization was found to be dependent on pacing (external vs internal), general ability, and the type of instructional objective. Integration of abstract and realistic visualization was found to improve effectiveness for externally-paced instruction under certain conditions.

Gagne (1967) supports the view that learning "is a highly idiosyncratic event, and depends very much on the nature of the learner, particularly on his own past learning."

Davis, Alexander and Yelon (1974) emphasize: "the most critical factor in determining student achievement on an instructional unit, is how much he knows about the material to be covered when he enters the unit. Consequently, it is absolutely essential to control for this factor when comparing two methods of instruction."

The purpose of this study was to investigate the effect of the level of knowledge of the subject on the instructional effectiveness of illustrations which integrate abstract and realistic visualization. Two methods of integrating the visualization were investigated. The first was with a hybrid illustration, a real color photograph into which a line drawing segment has been inserted. This provided an abstract illustration of the important relevant elements to be communicated, as well as a realistic context. The second method was through the simultaneous presentation of both a line drawing and a real color photograph. In this treatment the abstract line drawing could communicate the essential information and/or facilitate looking at the realistic illustration. The realistic illustration, on the other hand, could motivate and arouse as well as communicate essential information. The effectiveness of these treatments was measured for five kinds of learning objectives, externally-paced and self-paced methods of instruction, immediate and delayed retention, and three levels of prior knowledge of the subject.

Procedure

Subjects were 414 tenth grade public school students enrolled in mandatory health classes. Classes were coeducational and there was no ability grouping. The subjects were stratified into three groups on the basis of their scores on a physiology pretest which was administered during the two weeks prior to receipt of the instructional unit. The test is the same instrument used as a pretest by Dwyer (1972). There are 36 multiple choice items regarding general human physiology. Raw scores ranged from three to 33, with a mean of 17.1 and standard deviation of 5.8. The reliability (Kuder-Richardson 21) of the test was .75.

The instructional unit and criterion tests were those developed and used by Dwyer (1972). The 2,000 word instructional script deals with the construction and operation of the heart and is accompanied by 37 visuals which illustrate concepts and relationships for which visualization is likely to be beneficial.

The criterion tests were a drawing test with 18 items and identification, terminology and comprehension tests with 20 items each. Together these four tests constituted a total criterion test. Reliabilities (KR-20) of the individual tests equal or exceed .76. The reliability of the total test is .91, according to Dwyer (1972, p. 12).

Half of the subjects received self-paced written instruction and half received externally-paced instruction by an audio tape recording (with visuals in booklet form for both modes). Within each of these two modes the students received one of the five treatments: instruction with simple line drawings, instruction with realistic color photographs (3X5 inches), instruction with both line drawings and color photographs, instruction with hybrid illustrations of realistic photograph and line drawing segments, and a control group with no visuals. Treatments were randomly assigned to subjects. All students received the four-part criterion test on the day immediately following the instruction and again after two weeks.

The analysis involved a three-factor design denoted RS_n in (A_5 @ B_2 @ C_3). Random subjects were nested in cells formed by the three factors:

Factor A: Five levels of the instruction variable, 1) no illustration (control), 2) line drawing, 3) real photograph, 4) hybrid illustration and 5) both a line drawing and a real photograph.

Factor B: Two levels of the presentation mode variable, 1) externally-paced and, 2) internally-paced.

Factor C: Three levels of the entering behavior variable, 1) low, 2) medium and 3) high knowledge of the subject.

The analysis was completed for five levels of the dependent criterion variable, 1) drawing test score, 2) identification test score, 3) terminology test score, 4) the comprehension test score and 5) a total criterion test score which combined the other 4 scores. Scores on these tests were transformed to standard scores before analysis.

The library program RUMMAGE was used for the analysis of variance computations. This program will handle balanced and unbalanced experimental designs, missing data and transformations. Cell sizes averaged 12 for the immediate posttest and 14 for the delayed posttest.

Immediate Posttest: Results

Drawing Test

The analysis of variance procedure for the drawing test produced a significant* F value for the AC interaction (type of visualization vs. level of prior knowledge) and for B factor (pacing).

Tests of the B means indicated that the externally-paced subjects scored significantly higher than the self-paced subjects.

Figure 1 illustrates the AC means. There were no significant differences between the means for the low prior knowledge group. For the medium level, the Both Treatment was significantly more effective than the control group.

---

* $\alpha = .05$ for all tests

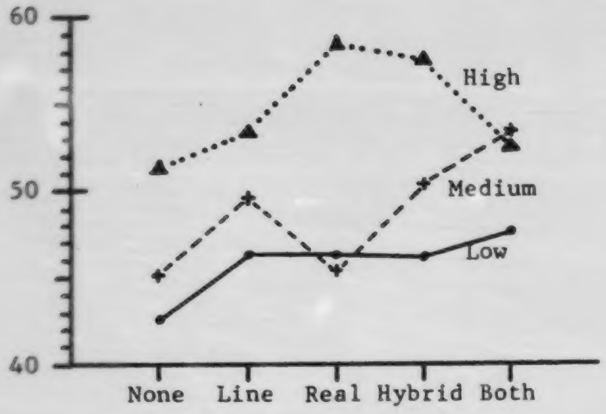


Figure 1 Drawing Test

For the high level, the Real photograph and the Hybrid illustration were significantly more effective than the control group.

Identification Test

The analysis of variance procedure for the identification test produced a significant F value for the ABC interaction. Figures 2 and 3 illustrate the AC means for externally- and self-paced instruction, respectively. There were no significant differences between the means for the low level prior knowledge groups. For the medium level, with external pacing, the Both treatment was significantly more effective than the control group. For the high level, with external pacing, the Both treatment was significantly less effective than the other four treatments. In the high level group with self-paced materials,

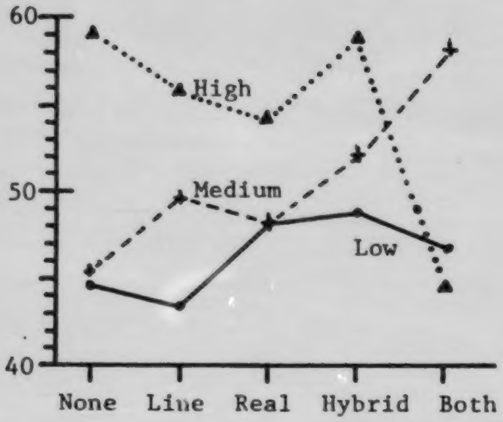


Figure 2 Identification Test
(Externally-paced)

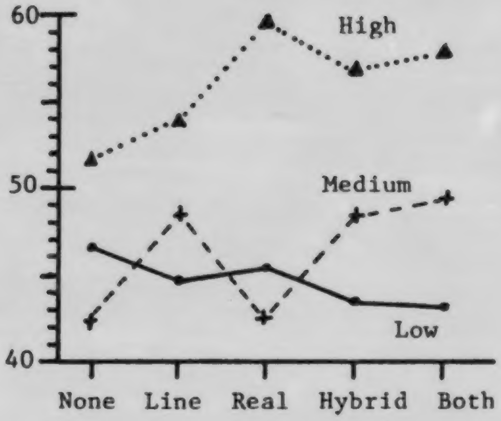


Figure 3 Identification Test
(Self-paced)

the real photograph was significantly more effective than the control group.

Terminology Test

Only the prior knowledge factor (C) produced a significant F ratio in the analysis of variance procedure for the terminology test. For this test the mean of the high level group was significantly higher than those of the medium and low level groups. The low and medium level groups did not differ significantly.

Comprehension Test

Only the prior knowledge factor again produced a significant F radio for the comprehension test. Results of the pair-wise comparisons of means were identical to those for the Terminology test above

Total score

The analysis of variance procedure for the total scores produced a significant F value for the ABC interaction. Figures 4 and 5 illustrate the AC means for externally-paced and self-paced instruction, respectively.

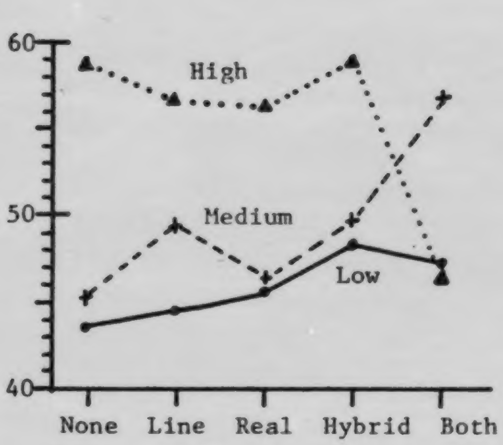


Figure 4 Total Score
(Externally-paced)

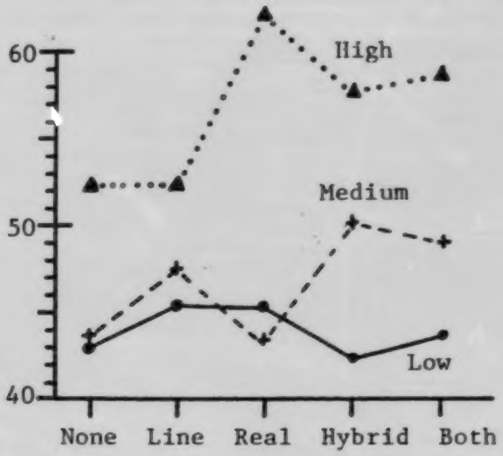


Figure 5 Total Score
(Self-paced)

There were no significant differences between the means for the low level prior knowledge group.

For the medium level, with external pacing the Both treatment was significantly more effective than the control group.

For the high level, with external pacing, the Both treatment was significantly less effective than the other four treatments. In the high level group with self-paced materials, the Real photograph was significantly more effective than the control group. These results for the total test score were identical to those for the identification test.

Immediate Posttest: Discussion

The results seemed to indicate that for students with little prior knowledge of the subject, the various types of visuals are equally effective. However, for students with medium and high levels of prior knowledge of this subject some types of visuals are more effective than others, depending on the method of instruction.

Students with a medium level of knowledge of the subject benefited from simultaneous presentation of both real and abstract visuals particularly for the kind of learning measured by the drawing test and, when externally paced, by the identification test and total test score.

The realistic visual was most effective for high level groups, particularly for the drawing test and, when self-paced instruction was used, for the identification and total test scores. The disparate result for the Both treatment with high level students in the externally-paced mode merits further investigation. If it is not spurious, it may suggest that this redundant illustration interferes with learning for students with high prior knowledge of the subject.

The results lend support to the notion that the effectiveness of certain types of visuals is related to the level of prior knowledge of the subject. Students with moderate levels of prior knowledge of the subject benefit from the integration of realistic and abstract visualization, particularly when instruction is externally-paced. Students with high levels of prior knowledge of the subject are able to benefit more from realistic visuals, particularly when instruction is self-paced.

Delayed Posttest: Results

Drawing Test

Only the prior knowledge factor (C) produced a significant F ratio in the analysis of variance procedure for the drawing test. For this test the scores of the low prior knowledge group were significantly lower than those of the medium and higher groups. Similarly, the medium prior knowledge group scored significantly lower than the high group.

Identification Test

Only the prior knowledge factor produced a significant F ratio for the identification test as well. The low and medium level groups were not significantly different. However, both differed significantly from the high level group.

Terminology Test

The analysis of variance procedure revealed a significant ABC interaction for the terminology test scores. Figures 6 and 7 illustrate the AC means for external and self-paced instruction respectively.

For the low level group with self pacing, the real photograph was significantly more effective than the control group. There were no significant differences for the externally-paced low level group.

For the medium level, externally-paced, the Both treatment was significantly more effective than the real photograph used alone. In the self-paced medium level group only the hybrid visual was significantly more effective than the control group.

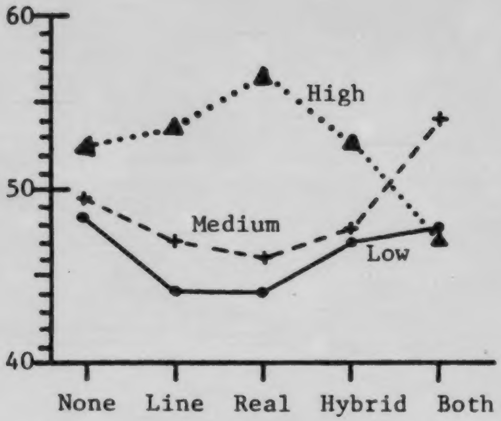


Figure 6 Terminology Test
(Externally-paced)

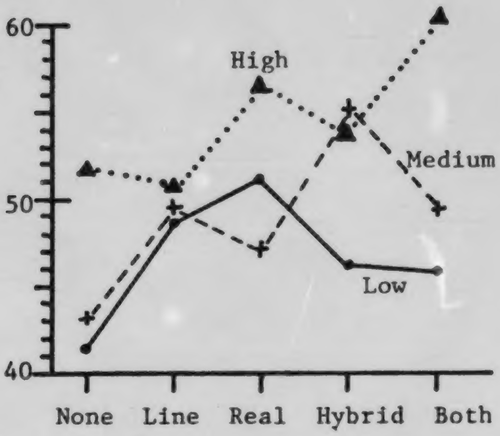


Figure 7 Terminology Test
(Self-paced)

For the high level externally-paced group, real photographs resulted in significantly higher scores than did the Both treatment. In the self-paced groups, the Both Treatment was significantly more effective than all other groups, except those receiving real photographs.

Comprehension Test

Only the prior knowledge factor produced a significant F ratio in the analysis of variance procedure for the comprehension test. As with the identification test, the low and medium level groups were not significantly different; however, both differed significantly from the high level group.

Total Score

The analysis of variance procedure for the total scores produced a significant F value for the ABC interaction. Figures 8 and 9 illustrate the AC means for externally-paced and self-paced instruction respectively.

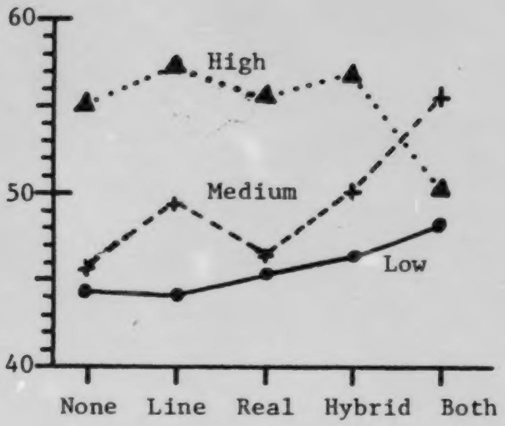


Figure 8 Total Score
(Externally-paced)

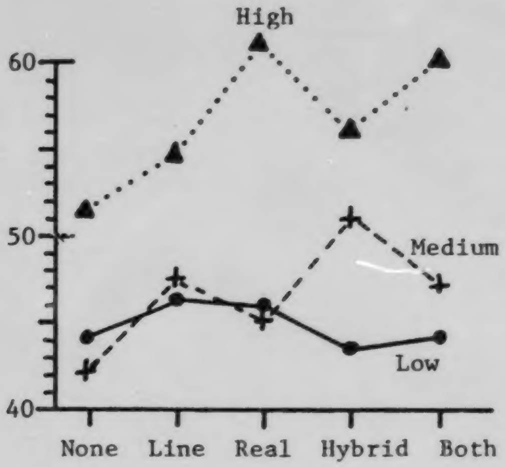


Figure 9 Total Score
(Self-paced)

There were no significant differences between the means for the low level prior knowledge group.

For the medium level, with external pacing, the Both treatment was signicantly more effective than the control group treatment. Only the hybrid visual was significantly more effective than the control group treatment with self pacing.

For the high level groups, with external pacing, the line drawing was significantly more effective than both types of visuals presented together.

For the self-paced groups, the real photograph and the Both treatment were significantly more effective than no visuals at all (control).

Delayed Posttest: Discussion

Delayed retention for subjects with a low level of prior knowledge of the subject was not generally influenced by the type of visualization. The one exception occurred with the terminology test in which these subjects, when utilizing self-paced instruction, found the realistic visual most effective. Apparently, the realistic visual enhanced long term memory for the kind of knowledge measured by the terminology test.

For students with moderate levels of prior knowledge, delayed retention was influenced by the type of visual for the kind of learning measured by the terminology test and the total test scores. These students who received externally-paced instruction benefited most from presentation of both types of visuals. When instruction was self-paced, the hybrid visual was most effective. For long term retention, the students appear to benefit most from integration of abstract and realistic visualization, although the most effective method of integration depends on the method of instruction.

For students with a high level of prior knowledge, the results paralleled those of the immediate posttest. For self-paced instruction the presentation of realistic visuals, or both types of visuals simultaneously, was most effective. However the presentation of both types did not enhance externally-paced instruction.

As in the case of the immediate retention results, these findings lend some support to the notion that increased level of knowledge of the subject may facilitate the utilization of more realistic or integrated visuals.

Conclusions

Results of both posttests suggest that designers of visualized instruction should consider the student's level of knowledge of the subject in determining the type of visualization to be used. Although students with a low level of general knowledge of the subject may find all types of visuals equally effective, students with moderate and high levels of knowledge of the subject may benefit from realistic visualization or illustrations which integrate abstract and realistic visualization, depending on the pacing of the instruction and the type of instructional objective.

TITLE: Coping With the Concrete Learner in the College Classroom

AUTHOR: Joanne Kurfiss

0008600

COPING WITH THE CONCRETE LEARNER IN THE COLLEGE CLASSROOM

Joanne Kurfiss, Ph.D.
Instructional Development
Weber State College
Ogden, Utah

All of us who teach have had the experience of being unable to "reach" certain students. We may attribute the difficulties to student motivation, student inability, or an undefined deficiency in our teaching methods. Depending on our degree of caring, our time and knowledge resources, and our current frustration level we seek ways to remedy the situation. Most often we are still left with a residual group of students who never really seem to master the concepts or methods we seek to convey. And as a rule we accept this as a fact of academic life, having something to do with the familiar (and comforting) notion that intellectual ability (whatever that may be) is "normally distributed" among "the population."

Lest you anticipate yet another diatribe against normative grading, let me hasten to state my contention: We are facing a kind of intellectual stagnation that is the end product of years of mental inaction on the part of our students. It's not that they are not bright; it's just that they've often not learned to "think" in the context of academic subjects. Active thinking is prerequisite to management of the abstractions students experience in college. To the degree that memorization suffices, students will memorize, but as the task demands more reorganization and integration of information and ideas, their strategy of memorizing will fail them, and they will indeed appear (and often feel) "dumb." Concepts which seem simple and fundamental to us as instructors often require intellectual gymnastics far beyond what students are capable of. We need to develop a healthy respect for the underlying complexity of principles that seem, on the face, to be readily understandable yet require mental activity which students are unaccustomed or unable to perform.

But what do we mean by "active thinking" or "mental activity?" Is not memorization an active (and important) mental process? Indeed it is, and has been the subject of extensive psychological investigation since Ebbinghaus' research in the late 1800's. However, the work of Jean Piaget has uncovered numerous other mental activities (he calls them "operations") and has provided extensive descriptions of their properties. The most important properties for our purpose are that mental operations:

1. Change and evolve with age, moving from inflexible, specific, and simple to flexible, generalizable and complex;
2. They require active, real world experience ("concrete" in Piaget's terms) in the manipulation of objects and events in order to reach their full expression;
3. They develop in response to the need to "make sense" of experience; and

4. Once the age and experience requirements are satisfied, the operations can "go underground;" that is, the thinker can think without the benefit of tangible objects as referents or potential referents.

Piaget thinks of this latter ability in terms of a "stage" of development, termed "formal operations" since the form, rather than the concrete reality, of a proposition or event is what directs thought. In the previous stage, concrete operations, the child can only reason about "real" things and their relationships; never about abstractions, hypothetical cases, or general laws.

Piaget devised numerous tests to determine how fully developed these operations had become for any individual. In his initial work on formal operations, he found 16 year-olds with well developed abilities. (Inhelder and Piaget, 1958) However, recent research indicates that in a variety of college student samples, formal operational thought is the exception rather than the rule (see Table I). Nonetheless, since most college faculty are formal thinkers, and probably have been since high school, and since most of us were taught by formal thinkers and did quite well under that approach, we tend to assume that our students have formal abilities, and we teach accordingly. As you read this, you are probably using formal abilities. You are, for example, understanding abstract concepts (I have so far given very few "concrete" examples). You are no doubt comparing your understanding to previous theories and beliefs about students. You may be making evaluative judgments (possibly thinking that your students are not like this!). Or you may be instantaneously grasping the implications of these ideas, recalling examples from your own teaching and learning experiences, and recognizing the power of this reconceptualization of what students are doing--all from a mere fragment of information.

To assist the reader in grasping the concept of a concrete-formal distinction, a list of formal tasks and concrete responses is presented in Table 2.[1] In addition, the bibliography will suggest some further readings on the subject.

How can the college teacher, accustomed as she is to formal thought and formal teaching, bridge the gap and help students learn--without sacrificing the integrity of the material? One way is to incorporate activities and materials into the regular lecture or lecture-discussion format of the class (see Table 3). Another is to take advantage of the model developed by Robert Karplus (1974) to teach particularly difficult concepts. The model is called the Learning Cycle; some of you may recognize parallels to the "inquiry method" used in science teaching for many years. The Learning Cycle is based on two assumptions of Piaget's theory of development:

1. Concrete experience helps people learn; and

2. Experiences that optimally challenge existing beliefs about the world are inherently motivating to the learner.

---

[1] In the workshop, an activity designed to dramatize the differences and enable participants to observe them firsthand will be used to supplement the table.

TABLE 1

CONCRETE, TRANSITIONAL, AND FORMAL THINKING IN COLLEGE STUDENTS[a]

Investigator(s)	Number of Students	Level of Students	% Concrete	% Trans.	% Formal
Arlin (1975)	60	Soph.	48[b]		52
Elkind (1962)	240	n.d.	42		58
MacKinnon & Renner (1971)	131	Fresh.	50	25	25
Pitt (1976)	14	Junior	15	14	71
Renner & Lawson (1973)	185	Fresh.	58 28		42[c] 72[d]
Schwebel (1972)	58	Fresh.	17		83
Tomlinson-Keasey (1972)	n.d.	Mixed	10	23	67
Tomlinson-Keasey & Keasey (1974)	24	Mixed	8	22	70
Towler & Wheatley (1971)	71	n.d.	39		61
Weber State College (1979)	51	Fresh.	27	57	16
Provo Technical (1979)	24	Fresh.	13	33	54

[a] All data except those from Weber State and Provo Tech are based on a summary presented in King (1977, pp. 84-46).

[b] Where Concrete and Transitional data are not presented separately, non-formal responses are grouped in the center column.

[c] Using the pendulum task

[d] Using the volume task

TABLE 2

THE CONCRETE LEARNER IN THE CLASSROOM

FORMAL TASK REQUIREMENTS	ANTICIPATED RESPONSE OF CONCRETE LEARNER	NOTES
Learning from predominantly verbal material (oral or written)	May show poor comprehension and retention, especially for very abstract, complex, or unfamiliar material	
Learning about unfamiliar objects or events; abstract concepts, properties, or relationships; axioms, or theories. Understanding metaphoric language, symbolism, or nonverbal behavior	Will interpret literally, focus on surface aspects, attempt to memorize rather than understand. Will be unable to detect underlying meanings, interpret symbols or behavior in context, or relate content to previously learned principles	
Executing lengthy or complex proceudres; planning new procedures based on general principles	Will require detailed, step-by-step instructions; best if illustrated, where feasible. "Guidelines" may not provide sufficient guidance.	
Imagining a point of view different (physically) from one's own; mentally transforming spatial relationships between objects	May require actual movement of self or objects. May perform needed transformations slowly or rely on overt movements representing the transformations required.	
Reasoning about proportional relationships; solving "word problems" involving proportions	May attempt to apply a rote formula and will often confuse the relationships involved as a consequence	
Reasoning about hypothetical situations, possibilities, or probabilities	May dispute the premise, arguing that it is not or could not be thus, so should not be discussed. In probability problems, may insist that one must examine entire population rather than estimate from a sample	

CONCRETE LEARNER

FORMAL TASK REQUIREMENTS	ANTICIPATED RESPONSE OF CONCRETE LEARNER	NOTES
Identifying all possible combinations of three or more objects	Will fail to use any systematic approach or will require prompting to use a previously learned system. May fail to identify full set or may duplicate responses due to lack of systematic approach.	
Reflecting upon one's own reasoning or the reasoning of others; evaluating consistency of an argument or plan; detecting underlying assumptions; taking the (psychological) point of view of another person	Fails to detect inconsistencies among statements or between statements and known facts. Thinks others are "reading between the lines" when they analyze assumptions or evaluate ideas. Has difficulty accepting ideas based on beliefs or experiences different than his/her own.	
Troubleshooting; using experimental method. Formulating hypotheses, selecting observations, and controlling variables to test a hypothesis systematically	May fail to note relevant information or may select irrelevant information to observe. May form confused or irrelevant hypotheses. Confounds variables when testing their effects. Draws invalid conclusions.	
Generalizing previously acquired knowledge to new but related situations	Tends to treat each situation as a totally new type of problem. May seem to have forgotten relevant skills learned in another context. When reminded, may ask (or simply wonder), "What's that got to do with this?"	

TABLE 3

How to Assist the Concrete Learner

Based on an analysis of the concrete learner in the classroom the following guidelines are offered for instructors desiring to adapt learning activities to the needs of their non-formal students. Specific applications will depend on the nature of the material being taught.

1. Provide abundant guided hands on learning experiences with models that can be manipulated or other appropriate equipment or materials.

2. Provide readily visible, accessible demonstrations, as well as opportunities to observe the process in its actual context whenever feasible. The value of these experiences is enhanced by providing explicit prior instructions as to what to look for during the demonstration or field visit, and by pointing out processes or phenomena to be studied as they are observed.

3. Provide frequent opportunities to solve "problems" and make discoveries related to the subject, using the actual materials involved whenever possible. Problem-solving takes many forms, from working a puzzle to getting a computer to run. It also occurs in the context of a well-constructed educational game. A close examination of teaching materials will often reveal a number of places where key concepts can be "discovered" rather than directly taught through reading or lecture. Discovery and problem-solving help the student transcend rote learning and transfer knowledge to new situations.

4. Use questioning techniques that stimulate application, analysis, synthesis and evaluation as opposed to recall of rote knowledge. Relate questions to ongoing activities of the student. Use "how" and "why" questions frequently. Encourage students to spell out their reasoning processes and to support them with reference to problems, materials, or concepts previously learned.

5. Help the student to make connections between skills and concepts being taught, and to integrate new knowledge with old. Use prompts, cues, and reminders to "jog" the learner's memory. Prepare the student to assimilate related ideas that will appear later in the course.

6. Encourage students to work together to solve problems. This enables them to test and challenge their own and each other's ideas, and heightens interest in achieving solutions.

Prepared by:
Joanne Kurfiss, Ph.D.
Office of Instructional Development
Weber State College
9/28/79

In Piagetian jargon, the latter is referred to as "inducing disequilibrium." The learner is obliged to reconcile old beliefs and new information that may seem at first to contradict the beliefs ("cognitive dissonance" is a more familiar term for much the same process). New and more generalized or integrative concepts are "discovered" or developed by the learner as a consequence of the effort to "make sense" of this contradiction. Table 4 summarizes the Learning Cycle model.[2]

To provide a "concrete example" of a learning cycle, consider a simple exercise designed by Elaine Cohen of Metropolitan State College, used to help students grasp the notion of inferences as opposed to observations. In the Exploration phase, a stranger to the student is asked to stand before the class. The students are asked to describe this person and their ideas are recorded. In the Invention phase, students discuss the basis on which they made their comments. Ideas such as past experience with persons of similar dress, appearance and manner, sterotyping, guessing, and other inferential processes are frequently mentioned. The difference between the basis of the description (e.g. long hair) and the inference from the observation (e.g. involved with drugs) can be brought out in the discussion. In the Application phase, many directions can be taken, depending on the purposes of the lesson. For instance, in a social psychology lesson on attribution theory, the professor may want to have students identify ways in which inferences are used to make attributions. In a literature class the teacher may want to have students consider how a good writer leads the reader to make inferences about characters, using examples the students seek in a book they are reading. In physics, the issue may be to help students understand how the behavior of particles is used to make inferences about the nature of those particles. The reader will hopefully see the uses of such an activity in his or her own discipline.[3]

The creative possibilities of the Learning Cycle are endless. Their use in conveying concepts that are fundamental or critical, as well as those which often seem to be most difficult for students to grasp, will aid the instructor in helping students master the goals and objectives of a unit, course, or program. Judicious use of learning cycles may also enhance student interest in the discipline under study. Where learning cycles are impractical, the guidelines provided in Table 3 can help the teacher in planning instruction that will "reach" the concrete learner. It is advisable when experimenting with this model to explain to students what it is you are trying to accomplish. Students accustomed to being "spoon-fed" are likely to be frustrated at suddenly being unable to capture the answers in their notes so that they can be memorized. A compensating benefit of this approach is that students will be unlikely ever to "forget" concepts they themselves have "discovered" or "invented" from their own experience and questions. Instead, they will find themselves able to generate information or hypotheses derived from their discoveries; in short, they will be "thinking" and enjoying it.

---

[2] In the workshop, participants will be introduced to the concepts of "inducing disequilibrium" and "learning cycles" through a learning cycle activity.

[3] Workshop participants will have an opportunity to create a learning cycle of their own. In addition, Sharon Hahs will discuss problems of implementing learning cycles and answer questions.

TABLE 4

THE LEARNING CYCLE MODEL
(Campbell, et al, 1979)

In applying the Piagetian technique to the classroom, a direct change in emphasis occurs: From the teacher (teacher-centered approach) to the student (student-centered approach). This is accomplished by using a learning model (called the Learning Cycle) which has three distinct and separate parts. Each is outlined below.

1. Exploration

Following a brief statement of topic and direction, students are encouraged to learn through their own experience. Activities may be supplied by the instructor which will help the students recall (and share) past concrete experiences or assimilate new concrete experiences helpful for later invention and/or application activities. During this activity the students receive only minimal guidance from their instructor and explore new ideas spontaneously.

Emphasis - Concrete experience.
Focus - Open-ended student activity.
Function - Student experience is joined with appropriate environmental disequilibrium.

2. Concept Invention

In this phase, the concrete experience provided in the exploration is used as the basis for generalizing a concept, for introducing a principle, or for providing an extension of students' skill or reasoning. Student and instructor roles in this activity may vary depending upon the nature of the content. Generally, students should be asked to "invent" part or all of the relationship for themselves with the instructor supplying encouragement and guidance when needed. This procedure allows for students to "self-regulate" and therefore move toward equilibrium with the concepts introduced.

Emphasis - Generalization of concrete experiences to abstract possibilities.
Focus - Student's active involvement with instructor for generalization.
Function - Student self-regulation and equilibration of generalized concepts and/or skills.

3. Concept Application

The application phase of the Learning Cycle allows each student an opportunity to directly apply the concept or skill learned during the invention activity. This activity allows additional time for accommodation required by students needing more time for equilibration. It also provides additional equilibrating experiences for students who have already accommodated the concepts introduced.

Emphasis - Relevant use of generalized concepts and/or skills.
Focus - Directed student activity.
Function - Further equilibration through broadening concrete experiences.

Although the Learning Cycle allows each student the opportunity to think for himself, the instructor must be an ever present "overseer" of the activity, and by providing probing questions, hints, and encouragement keep the activity going. Yet the instructor must guard against over playing his role as director and planner.

REFERENCES

Campbell, T.C.; Zucco, K. McGill, Phil; Taylor, K; and Thompson, R. The DOORS Project: Development of Operational Reasoning Skills. East Peoria, Ill.: Illinois Central College, 1979, Appendix.

Inhelder, B. and Piaget, J. The Growth of Logical Thinking From Childhood to Adolescence. New York: Basic Books, 1958.

Karplus, R. Science Curriculum Improvement Study. Teacher's Handbook. Berkeley, Calif.: University of California at Berkley, 1974.

SUGGESTED READINGS

Cowan, Philip. Piaget With Feeling: Cognitive, Social, and Emotional Dimensions. New York: Holt, Rinehart and Winston, 1978.

Elkind, David. Children and Adolescents. Oxford, New York: University Press, 1978.

Fuller, R.G. and Associates. Multidisciplinary Piaget-Based Programs for College Freshmen, 3rd ed. Lincoln, Nebraska: University of Nebraska, 1978.

Nader, Ralph. "Student Power 101." Change, 11 (8), 1979, 47-50. (Included because of his excellent examples of "hands-on" learning for college students.

Wadsworth, B.J. Piaget for the Classroom Teacher. New York: Longman, 1978.

TITLE: A Comprehensive and Critical Review of the Methodology and Findings in Color Investigations

AUTHOR: Richard J. Lamberski

A COMPREHENSIVE AND CRITICAL REVIEW OF THE METHODOLOGY AND FINDINGS IN COLOR INVESTIGATIONS

Richard J. Lamberski
Director - University Media Services
Assistant Professor - Division of Instructional Development
Boston University

Research & Theory Division
Association for Educational Communications & Technology
Denver, Colorado
Wednesday - April 23,1980

Lamberski, R. J. A comprehensive and critical review of the methodology and findings in color investigations. A paper presented at the Annual Convention of the Association for Educational Communications and Technology, Denver, CO, 1980.

ABSTRACT

Purpose

The purpose of this paper was to present a comprehensive and critical review of the existing literature relating to the effect of perceptual stimuli containing color. The study will emphasize particularly the literature relating to cognitive processing and color as a cue or code strategy.

Perspective

Research during the instructional media era of the 1950's and 1960's was comparative in nature and sought to identify device usefulness rather than to identify the parameters impacting on elements of the message. In surveying the color literature, researchers have concluded that the significance of color as a message design variable has typically eluded researchers who have attempted to define its unique role rather than its possible interrelated role in the acquisition and retrieval process.

Furthermore while color has received considerable attention in perceptual research investigations, the findings appear to have contributed little as to a possible role of color in cognitive functioning. This lack of conclusive evidence has been attributed to either limited experimental designs or to the inability to develop experimental materials which would be unbiased.

Method

An exhaustive eight year review identifying several hundred references with respective findings were interpreted by selected decision criteria. The primary topics include verbal color applications (in nonsense and meaningful word tasks) and visual color applications (in passive or active materials) as they relate to cognitive functioning and perceptual processing. Additional topics related to the stated purpose include information processing and memory systems, affective study of color, color in task tests, the relationship of color and time, and the efficiency of color.

Discussion

The paper provides new insights into the probable interrelated value or limitations of color as a variable in perceptual stimuli design. Current research methodology was discussed in light of needed experimentation.

A Comprehensive and Critical Review of the Methodology and Findings in Color Investigations

Introduction

The increasing complexity of instructional development activities during the last decade has prompted numerous models of learning systems to be offered for the improvement of instruction. Each model has its unique emphasis on priorities, strategies, and methodology in the manipulation of the integral and viable components of resources, management, learners, and development procedures. However, each model relies on empirical evidence to specify criteria from which decisions can be made as to the effectiveness of one strategy over another for facilitating learning. Therefore, this review of the literature seeks to provide evidence of the effect of color cueing and coding on instructional and test materials. The paper is intended to serve as a primer for future investigators. The paper identifies the majority of studies investigating the interrelationship of color with cognitive processes.

Limitations to the Review

The primary focus of the surveyed and presented literature concerns the effect of color on human cognitive learning from both theoretical and applied experimentation. During the process of the literature search, investigative areas were identified which, while using color as a primary variable, have findings not directly related or interpretable to the purpose of this review. These investigative areas included:

1. (1) animal subjects,
2. (2) preferences for a color,
3. (3) physics or chemistry of color perception,
4. (4) aesthetics of color to art and literature,
5. (5) cultural differences,
6. (6) special learner populations, and
7. (7) special applications (i.e., therapy, symbolism, marketing, personality, etc.).

If interested in these areas, the reader is referred to Sheppard (1968), Hochberg (1971, pp. 395-474), Parks (1975), Parks and Architecture (1975), Carterette and Friedman (1975), Moore (1977), and especially Billmeyer (1977).

Color: A Message Design Variable

In attempting to identify message design characteristics, it is important to realize the tremendous variety of choices for production and dissemination of instructional material that a practitioner has available. However, historically there have been only a few design characteristics which have received major attention. One such design characteristic is color.

The significance of color as a design variable has typically eluded researchers who have attempted to define its unique role in the learning process. In previous surveys, Lamberski (1972), Berry (1974), and Chute (1978) found that the reported research was often contradictory or inconclusive, and in many cases lacking practical application. They concluded that researchers may have: (1) failed to analyze the interrelatedness of color as a variable to other components within a learning system; or (2) had research design flaws that prohibited meaningful interpretation of results. It is from these conclusions that the following historical perspective for examining the effects of color in message design is presented.

Historical Perspective

The research of the instructional media era of the 1950's and the 1960's was comparative in nature, and sought to identify carrier device usefulness rather than message elements. The research questions posed were to justify using media rather than to optimize learning through its use. Thus, the use of color in investigations was superseded by other variables. In most investigations the color variable was not properly isolated by experimental design to assess its relative effectiveness (Chute, 1978, p. 8). Lumsdaine (1963) summarized this early comparative color research by stating:

> No really definitive studies have been made on the specific way in which color may contribute to learning from instructional materials . . . All that can really be concluded from the evidence is that the effects, if any, of color were not large enough to show up as the significant difference that would be predicted . . . the evidence suggests that any general value of color for increasing learning through increased strikingness or attractiveness has probably been overrated. (p. 635)

Five years later, Kanner (1968), surveying the comparative literature in color and black/white television, stated:

> It should be pointed out that, while the literature on color as a subject matter is enormous, when you focus down to the topic of color and human learning a scarcity of information is encountered. (p. 1)

Kanner concluded from his survey that the use of color in instructional materials does not significantly improve cognitive learning. This was due primarily to the hypothesis that:

> . . . words or labels can be substituted for the actual perception of color by the learner. (p. 5) /Or/ . . . that the verbal coding or substitution of words for color more than compensated for not seeing the color. (p. 6)

In a comprehensive review of the literature on color-form-number preference of children, Otto and Askov (1968) made observations which marked the beginning of a transitional stage in the study of color as a secondary variable to a primary and manipulated variable. They described the problem:

> In general, no real attempt has been made to draw upon existing research and theory regarding the role of color in learning; instead, color has simply been used as an added information-bearing cue. (p. 161) . . . The salient implications of all the existing research on the role of color is fragile at best and apt to be superseded by more potent cues . . . to sum up, at the present time, the use of color cues in instruction has never had a truly fair trial. The reason for this appears to be that the relevant variables have not been identified and considered. (p. 163)

After several years of channel capacity research in which color was an embellishment in the visual channel, Travers (1970) concluded that:

> Color does not seem to add sufficient interest value or attention-getting value to a presentation to produce any measurable effect on learning. Perhaps the only general justification for the use of color is that it provided a more pleasing aesthetic experience than does black and white. The study of color versus black and white provided a useful kind of finding, but not one that has any great implications for solving any major and central issue related to the design of audio-visual material. (pp. 4-5)

These early attempts to define and question the value of color have since generated a wealth of research reviews and investigations on color as a perceptual and design variable. Table 1

Table 1. Selected Major Reviews of Color Research and Investigation.

Year	Investigators	Area of Color Interest
1967	Chu & Schramm	Film & Television
1968	Otto & Askov	Childhood Development of Preferences
1968	Kanner	Television
1969	Isaacs	Coding of Pictorial Stimuli
1972	Vollan	Description of Dynamic Content
1972	Lamberski	Cognitive Instruction and Testing
1972	Dwyer	Realism in Visualization
1973	Kauffman	Cartoons & Professional Background
1973	Rudnick, Porter, & Suydam	Pictorial Stimulus Variables
1974	Plack & Shick	Physical, Perceptual, & Emotional Responses
1974	Berry	Realism in Visualization
1974	Rudnick	Attention-getting & Perceptual Styles
1975	Christ	Visual Search in Target Acquisition
1975	Parks	Perception & Aesthetics
1975	Parks & Architecture	Perception & Aesthetics
1976	Puig	Television
1976	Spears	Television
1978	Chute	Film & Spatial Abilities
1978	Dwyer	Visualized Instruction
1980	Lamberski	Cognitive Instruction & Testing

presents some of the color literature reviews and research; it is apparent that the study of color is of current interest. In the time period covered by the present investigator's literature survey (from 1945 to 1980), individual research studies where color has been a primary experimental variable or a secondary variable number well in the hundreds. While this represents a staggering amount of research, only a limited number of interpretable or generalizable conclusions can be drawn from this body of data. Chute (1978) recently summarized the dilemma of color research:

> . . . the value of color as a stimulus variable was often overestimated because the color stimulus was not considered in relationship to other salient cues in the visual array. Color was studied as the unique and isolated stimulus variable. A major limitation of this approach was the difficulty of integrating the color research into the greater body of educational research investigating other stimulus variables. It seems apparent there is a need for a broader understanding of the functions colors can have in perception, human information processing, and learning in general. (p. 4)

To summarize, while color has received considerable attention in perceptual research investigations the findings appear to have contributed little as to a possible interrelated role of color in cognitive learning. This lack of conclusive evidence has been attributed to either limited experimental designs or to the inability to develop experimental materials which would be unbiased. In most color studies decision criteria or parameters were not clearly defined or the interrelatedness of those decision criteria evaluated.

Verbal Color Applications

The application of color as a structuring device in verbal tasks has been both as a contextual cue (physical form within the stimulus) and as a contextual and associative code (physical form with meaningful value). Cue is defined as a verbal or visual strategy by which the perceiver's attention is focused upon perceptual information. A code is defined as a method of structuring perceptual and associative information for the purpose of facilitating learning, retention, and recall.

The application of color to verbal tasks may be divided into two areas: nonsense and meaningful word tasks, and prose tasks. For purposes of discussion, the literature will be separated into these two areas.

Color in Nonsense and Meaningful Word Tasks

The largest application of color within verbal investigations involves color being applied in or around printed trigrams, letters, words, shapes, and numbers. The cue value of color was either central (primary/relevant/intentional) or peripheral (redundant/irrelevant/incidental) to the learning of a concept.

The application of color in these nonsense word tasks may be subdivided into experimental categories; the first and largest category was that of paired associate tasks. Investigations in this category have indicated that color will enhance the recall of the paired associate, especially when matched with a nonmeaningful trigram, letter, number,or shape (Committee on Colorimetry, 1954; Weiss and Margoluis, 1954; Peterson and Peterson, 1957; Underwood, Ham, and

Ekstrand, 1962; Saltz, 1963; Berry, 1969; Goodman, 1975; Buchanan, 1975). Research further showed that the selection of color as the primary cue was enhanced if: (1) other contextual cues lacked physical form differences; (2) the associative value of words were difficult or low in meaning; (3) color was perceived as being useful; or (4) color was told to be of value (Isaacs, 1966; Swede and McNulty, 1967; Otto and Askov, 1968; Corballis and Luthe, 1971; Arnold and Bower, 1972; Bower, 1972; Newby and Young, 1972; Light, et al., 1975; Buchanan, 1975; Petrich and Chiesi, 1976; Winn, 1976; 1977).

Having learned concepts using a color contextual cue, the initial benefit did not necessarily transfer to similar tasks or benefit the learner when totally removed or altered in later testing (Saltz, 1963; Swede and NcNulty, 1967; Otto and Askov, 1968; Samuels, 1967; Washington, 1968; Goodman, 1975). Indeed the color cue superiority lost effectiveness rapidly unless practiced or reinforced (Randel and Havrda, 1968; O'Brien, 1971; Sabo and Hagen, 1973; Buchanan, 1975), overlearned (Gottlieb and Lindauer, 1967; Washington, 1968), or faded to some other non-color dimension (Allington, 1973; Goodman and Cundick, 1976).

A second category of experimentation has been in color-word interference tasks, or what has been termed the Stroop Test (Dyer, 1972; Nielsen, 1975), a test of recall of color names or nonsense words in conflicting color print. The Stroop Test demonstrated that several dimensions of information (verbal and visual) were acquired and retrieved by different but interrelated processing and memory structures (Majeres, 1970; Nealis, 1974; Harrison and Boese, 1976). The Stroop Test demonstrated that the use of color in printed meaningful words caused processing interference resulting in longer processing time.

A third category of experimentation has been that of color application in order to isolate central or peripheral concepts. Investigators (Sabo and Hagen, 1973; Sato, 1976) have found that the recognition of the intentional concept is (1) improved when the color cue differentiated the central from the peripheral stimuli, and (2) increased with development or age. This age enhancement of central stimuli appears to be more a function of encoding and rehearsal strategies of older learners rather than the younger learner's inability to disregard peripheral stimuli (Hale and Taweel, 1972; Sabo and Hagen, 1973). The recall of peripheral stimuli has been found to increase with multiple presentations of centrally color cued stimuli (Sato, 1976).

The fourth category of verbal color application has been in the use of color in meaningful word-visual association. Researchers (Wicker, 1970; Ernest and Paivio, 1971; Light, et al., 1975; Yurkiw and Gounard, 1975; Denis, 1976) found that colors, when used in association or to emphasize, have significantly enhanced the recall of pictures and facilitated the learning or recall of words; Ernest and Paivio (1971) attributed this enhancement of pictorial recall to stimulus concreteness found only in visual memory. It has also been suggested that color's usefulness in meaningful word tasks was apparently conditional on associative meaning (Deich, 1972; Gardiner, et al., 1976). Other concurring evidence suggested that the associative value of color with words or pictures may be more beneficial to concept attainment than the differences attributable solely to the physical form of color (Underwood and Freund, 1969;

Winn, 1976; 1977). Thus it appears that in this combined potential of stimulus concreteness and associative value, a color cue may become a valuable color code.

Color in Prose Tasks

A smaller investigative area involves meaningful prose materials in which color was used as a code having physical form (underlining, shaded areas, arrows, or printed words) and associative value (meaning). The instructional value of color in these incidences was mostly central (primary/relevant/intentional) acting as a strategy for concept attainment or improved performance.

Applications in this verbal area predominantly involved color codes in reading (Gattegno, 1962; Cruickshank, 1967; Jones, 1968) and phonic materials (Bannatyne, 1966; Knafle, 1974; Lyczak, 1976) which utilize color print to convey meaningful reading and pronunciation directions to the learner. Generally these researchers found that color coded materials were preferred by learners over other coding systems, and furthermore, learning rates and learner performance improved with the color coded materials. After investigating and validating learner reading achievement with color coded material, Hinds and Dodds (1968) have stated that the use of color:

> . . . gives the learner a stable and unchanging code of organization and sequence, which helps lend security in the learning process. Color, through its stimulation, rivets and holds the attention of the learner. (p. 46)

Visual Color Applications

In assessing the cue value of color in visualized learning materials, a separation of the literature can be made as to how color was applied. This separation of learning materials into two "carrier" categories, passive and active, has been suggested by Gropper (1976). Generally passive materials are normally not controlled by the learner (externally paced); examples of passive materials are film, television, and audio-slide presentations. Active materials are usually controlled by the learner (internally or self-paced); examples of active learning materials are programmed instruction and computer assisted instruction. The similarity between passive and active materials is that in most incidences the concepts are simultaneously presented with oral or verbal and visual information.

Color in Passive Materials

In reviewing color application in externally paced investigations, a variety of passive materials have been combined. These passive materials include television, film, pictures, charts, transparencies, and slides which were complemented by a synchronous narrative or complemented by a supplementary narrative on audiotape or live lecture. In most investigations the cue value of color is peripheral (redundant/irrelevant/incidental) to the learning of a concept.

Many researchers have concluded that color in passive materials was equal to or less than black/white materials for facilitating learner achievement (Long, 1946; Gibson, 1947;

VanderMeer, 1949; 1952; 1954; Zuckerman, 1954; Schwerin, 1957; May and Lumsdaine, 1958; Hudson, 1958; Kanner and Rosenstein, 1960; Rosenstein and Kanner, 1961; Link, 1961; Chu and Schramm, 1967; Kanner, 1968; O'Connor, 1970; Kaneko, 1971; Bretz, 1971; Reich and Meisner, 1973; 1976; Spears, 1976). For example, color was found to be inferior to black/white passive materials for different tasks and retention testings when used with college learners and adults possessing different educational backgrounds (Lamberski, 1972; 1975; Kauffman and Dwyer, 1974). Some researchers have suggested that color, since primarily peripheral, may distract the learner's attention from the important learning cues (Hoban and VanOrmer, 1950; VanderMeer, 1952; Chute, 1978). Other researchers have concluded that color will generally only enhance passive learning materials when it is used to emphasize relevant cues or aid in making discriminations (Norman and Rieber, 1968; Tolliver, 1970; Dwyer, 1972; Schramm, 1972; Brown, 1973; Rudnick, et al., 1973; Powers and Shrader, 1975).

When color does increase recall and recognition of passive materials, especially of peripheral stimuli, it is usually at the loss of the more relevant narrative information (Kumata, 1960; Deutschmann, et al., 1961; Chan, et al., 1965; Travers, et al., 1965; Schaps and Guest, 1968; Chute, 1978). Furthermore, it has been found that the effectiveness of color in passive materials appears more dependent on age or grade level with younger learners with generally higher performance being achieved with color materials (Travers, 1969; Booth, 1971; Casey, 1972; Miller, 1972; DeLucia, 1975). Given these supportive findings of color effectiveness, it has been suggested that once color is encoded, it may inhibit forgetting of learned material and thereby facilitate delayed retention (VanderMeer, 1952; 1954; Lamberski, 1972; 1975; Kauffman and Dwyer, 1974; Scull, 1974; Hoban, 1975; Farley and Grant, 1976). However, further investigations are necessary to substantiate this proposition.

When specific applications are noted, color has been found to facilitate learning from passive materials when used: in highly visual (spatial) tasks (Dwyer, 1972; Reich and Meisner, 1973; Shaw, 1975); in dramatic portrayal (Reich and Meisner, 1973); and in the perception of movement (Travers, 1969). These findings, in addition to other findings reviewed in this chapter, have made some researchers suggest that the color may have limited application to the learning of low level cognitive concepts and is of more value in the modification of attitude (Schweitzer, 1963; Caban, 1971; Field, 1972; Spangenberg, 1976; Chute, 1978).

Thus far, the reported investigations in passive materials have primarily used color as a physical form carrying no associative value. However, Lamberski (1972; 1975) did investigate the code value of color in verbal information with accompanying visualization. The results showed that learners who received a color code in instruction and testing materials had significantly inferior achievement than learners who received black/white materials for immediate retention tasks, and generally had less achievement than learners who received black/white materials for two-week delayed retention tasks. It was concluded that the difficulty of information acquisition and task retrieval requirements limited the potential of the color code; this was attributed to insufficient processing time brought about by the externally paced format. It was further concluded that learners who received the black/white instruction and testing materials had less distraction and therefore more time to attend to the more central acquisition and retrieval tasks.

Thus, the application of color as a cue or code to externally paced materials appears highly task specific and generally has been utilized inappropriately, particularly when the relevant information is contained in the oral narration or verbal labels.

Color in Active Materials

There is only a limited number of investigations that applied color to active materials. These internally or self-paced materials include posters, comic books, textbooks, programmed instruction, and photographs. The cue value of color in most of these surveyed investigations was peripheral (redundant/irrelevant/incidental) to the learning of a concept.

The surveyed research presents contradictory evidence for the value of color in active materials; at best the cue value of color is again highly task dependent. Some researchers have concluded that color does not facilitate the learning of concepts in active materials (Travers, et al., 1964; Scarpinc, 1972; Dooley and Harkins, 1970; Scull, 1974). For example, Dwyer (1972), in a compendium of his research studies, found that programmed booklets complemented by color visualization were generally inferior to black/white materials for a highly visual task such as drawing, and furthermore were equal to programmed text material containing no visualization for a highly verbal task such as comprehension. Freed (1963), using color in self-paced training materials, has shown that color visualization will imapir transfer from training to real task application.

When color has been found to facilitate achievement in active materials, it has been for low perceptual tasks. These tasks include the recognition or discrimination of content (MacLean, 1930; Ibison, 1952; Davis, 1975), and the immediate recall of peripheral material (Katzman and Nyenhuis, 1972).

Most recently Lamberski (1980b) has conducted a study to assess the relative achievement effect of a verbal and visual color or black/white coding strategy. The coding was incorporated into self-paced instruction and test materials and was intended to facilitate student retention on different cognitive tasks. Major findings indicated that color coded self-paced instruction materials were superior to the black/white coded instruction materials for both immediate and six-week delayed retention and on all task tests (drawing, terminology, identification, and comprehension). However, the presence or absence of the color code in test materials had no significant effect on student achievement. Lamberski concluded that the effectiveness of the color coded instruction materials may reside in their ability to demand sustained student attention and interaction with the content along with their ability to be able to provide an enhanced associative memory structure. Results also indicated that the color coding had a more positive impact on tests representing visual tasks (drawing, identification) rather than the more verbal tasks (terminology, comprehension). Also noted was the drop in recall from immediate to delayed retention testing, which though statistically different, evidenced a similar percentage decline for both color coding and black/white instructional groups.

The Affective Study of Color

Having presented the findings of verbal and visual color application, several additional areas of color and perceptual research offer support for the potential value of color stimuli in instruction and testing materials. The first of these contains studies relating to the affective value of color.

An affective component of the learner, learner preference, has repeatedly been found to increase the recall of concepts presented in a favored verbal or visual mode (Ingersoll, 1970; Farr, 1971; Kalin, 1972; Lilly and Kelleher, 1973; Daniel and Tacker, 1974). These researchers have indicated that learner preference may influence learning by directly influencing attention. In this light there is conclusive evidence that color materials are preferred over non-color materials (Gibson, 1947; Malter, 1948; VanderMeer, 1952; 1954; May and Lumsdaine, 1958; English, 1961; Schweitzer, 1963; Travers, et al., 1964; Jones, 1965; Chu and Schramm, 1967; Dwyer, 1972; Lamberski, 1972; Katzman and Nyenhuis, 1972; Scarpino, 1972; Puig, 1976; Chute, (1978). Therefore a preferred color design strategy may contribute in facilitating cognitive learning in addition to enhancing learner attitude. Such preference for color has been suggested to increase attention and motivation (Schwerin, 1957; May and Lumsdaine, 1958; Birren, 1963; Dooley and Harkins, 1970; Dwyer, 1972; 1976a; Schramm, 1972).

However it has been found that the preference for color is not a necessary condition for learning; in fact, color preference does not seem to be correlated with concept achievement (VanderMeer, 1954; Dwyer, 1972; 1976b). Thus preference alone can not necessitate the use of color.

The Physiological and Developmental Study of Color

The second supportive research area involves the physiological and developmental study of color. The research findings in these endeavors indicate a meaningful role of color in human perception. Data indicates that color can cause physiological, perceptual, and emotional reactions and associations within the learner (Goldstein, 1942; Cheskin, 1948; Kouwer, 1949; Rudisill, 1952; Collier, 1957; Gerard, 1958; Smith, 1958; Birren, 1959; 1963; Schwartz, 1960; Roseheim, 1967; Child, 1968; Nourse and Welch, 1971). For example, the recognition of familiar or unfamiliar color stimulus affects heart rate, blood pressure, and perceptual judgments of size, weight, and distance in both infants and adults (Plack and Shick, 1974; Bornstein, 1975; Adkinson and Berg, 1976; Bornstein, et al., 1976). These intensified reactions and associations are perhaps related to the increased attention and motivation exhibited by learners with color materials.

Recent research in perception has provided the most influential findings for the advocacy of color coding. Findings indicate that once a stimulus is perceived, the retina and cortex categorizes the stimulus into color codes (Murch, 1974; Vidyasagar, 1976; Land, 1978). This physiological color coding of the stimulus has been found to be a function of the number of physical forms and processing time (Young, 1973; Galbraith, et al., 1975), luminance levels within the rods (Ambler and Proctor, 1976), and hemispheric brain properties (Meyer, 1975). The evidence suggests that we involuntarily process color into codes.

The study of human development has also supplied data which suggests that the value of visual attributes, like color, changes in the maturation process; it is generally viewed that this perceptual change parallels development of verbal skills with increasing reliance on associative strategies (Crowder, 1976; Estes, 1976).

For example, with older learners it has been reported that color as a visual cue becomes integrated with verbal information in the processing, encoding, and retrieval of concepts (Daehler, et al., 1969; 1976; Hale and Green, 1976). It has also been found that learners at any age are not necessarily deficient in the encoding of coded information during acquisition, but poor recall may be attributed to failure in using the acquired codes at the time of retrieval (Martin and Richards, 1972; Geis, 1974). Previously cited color research by Lamberski (1980b) supports both these contentions.

Color in Task Tests

The question of the value of color on retrieval tasks appears to have no simple answer. Frechtling (1970) and Dwyer (1972) have found that the significant retrieval value of color or other perceptual cues is highly dependent upon the instruction and testing tasks, the materials used, the complexity of the visualization, the age of the learner, the learner's attention and motivation, and the amount of interactive time. There is evidence suggesting that color presentation cues in passive materials facilitate recall in visual tasks more than in verbal tasks (Otto and Askov, 1968; Dwyer, 1972), but the application of color stimuli in testing instruments is limited.

The research evidence that is available has applied and evaluated color in low perceptual tasks. These low perceptual tasks include searching, counting, sorting, discriminating, locating, and recognizing. Schontz, et al., (1971) summarized color's usefulness in a low perceptual task by stating that color will facilitate retrieval if: (1) many categories of information have been coded; (2) the number of concepts per category is small; and (3) colors are highly discriminable.

In studies of more complex tasks, Saltz (1963) and Lamberski (1975) have found that once a color code has been integrated during the acquisition of a concept, the altering of the color code at retrieval may cause interference, having an adverse effect on learner recall. This trend was also noted by Lamberski (1980b) in self-paced materials, but failed to reach a meaningful significance level.

Research has also found a trend that if color is added to the retrieval tasks, for learners who had received black/white instruction, interference will again occur (Dulsky, 1935; Lamberski, 1975). Again, this trend was noted by Lamberski (1980b) in self-paced materials, but failed to reach a meaningful significance level. Contradicting this finding Saltz (1963) indicates that color cues have facilitated retrieval when used only in the testing of concepts; Saltz attributed this effect to cognitive differentiation during testing conditions.

Further investigative research is needed to clarify these findings.

In the investigation of coded materials in testing, Bourne (1959) and Lamberski (1972) have both found that the administering of an immediate test after concept instruction will facilitate learner achievement at later delayed testing. This effect was apparently caused by reinforcement, rehearsal, and retrieval of the encoded stimulus during immediate testing making the acquired concepts more resistant to mamory and retrieval interference. However, the presence or absence of color in self-paced testing materials does not appear to be a significant factor for student achievement; rather, the presence of color coding during the acquisition of concepts appears to enhance learner achievement (Lamberski, 1980b). This enhanced learner achievement appears greatest for more visual tasks and diminishes as the task becomes more verbal.

The Relationship of Color and Time

The amount of time permitted for a task will partially determine the cue value of color or the cue value of other physical forms of the stimuli (Gordon, et al., 1967). Given unlimited time, color codes in some perceptual tasks have produced superior learner performance and speed for visual search or sort tasks (Jones, 1965; Harris, et al., 1964; Schioldberg, et al., 1973; Luria and Strauss, 1975). However, when time is limited, color has been found to impair learner speed and precise discrimination of objects (Jones, 1962), having a facilitating effect only in certain low perceptual tasks such as picture recognition (Fleming and Sheikhian, 1972; Berry, 1977) or reaction time (Samuels, 1967; Logan, 1976).

In more complex tasks, researchers have suggested that the use of color in materials will require more time to be perceived, processed, and stored (Dwyer, 1972; Berry, 1974). However, investigative evidence has found no clear support for the relation of color to learning time or retrieval time. In some investigations the data were inconclusive (Rust, 1967; Scarpino, 1972; Katzman and Nyenhuis, 1972), while in other studies color was found to reduce learning time (VanBuskirk, 1932; Funkhouse, 1968).

The lack of conclusive data on the effect of color in relation to acquisition and retrieval time prompted Berry (1974) to state that an investigation should be conducted utilizing color:

> . . . in an internally or self-paced format rather than externally paced. In this way, the time with which students interact with the visual materials could be examined as a significant variable contributing to the effectiveness of color as a cueing device. (p. 115)

In response to this need, a study was conducted by Lamberski (1980a) investigating the relationship of achievement to time with self-paced learning and test materials. Lamberski found that the mean time (minutes) that subjects required to work through a color coded instructional booklet was significantly greater than time needed to work through the instructional booklet in black/white. Lamberski further found a four-way interaction among presentation materials (color or black/white), evaluation materials (color or black/white), retention testing (immediate and six-week delayed), and type of task test (drawing, identification, terminology, and comprehension) when the dependent variable was the amount of time needed to interact with each task test. Most of this interaction appeared attributable to subjects who had received the color coded instruction and later received the color coded test materials; this was particularly evident for the more visual task tests.

Efficiency of a Color Code

In a new analysis area, researchers have attempted to analyze the relationship between learner achievement of concepts and the time needed to interact with color materials. The rationale is that the message should be designed not only for its achievement effect but also for the message efficiency. Efficiency, defined as achievement per unit of time, has been expressed in several different formulas. Lamberski and Roberts (1979) have observed the relationship using achievement divided by instruction time, achievement divided by test time, and achievement divided by instruction and test time. Lamberski (1980a) has observed the relationship using achievement gain (post-instruction achievement minus pre-instruction knowledge) divided by total time (time on instruction plus time on test). The observed results of these formulas have generally favored subjects who received self-paced color coded instruction material and self-paced black/white evaluation material. However, these exploratory analyses have not been statistically analyzed.

Recently, Lamberski and Myers (1980) conducted a study to assess the efficiency (achievement gain per instruction time) of a verbal and visual color or black/white code when used in self-paced learning and test materials. By accounting for the guessing and prior knowledge of the subjects, and by accounting for the different time necessary for processing information at acquisition for each treatment condition, it was shown that color and black/white coded materials produce similar efficiency results.

They concluded that the unlimited time allowed by the self-paced instructional materials benefited the students who received the color coded instruction by permitting necessary and sufficient rehearsal time. However, the acquiring of these concepts was time consuming, causing efficiency means comparable to subjects who received the black/white materials.

These findings support previous research (Hock and Egeth, 1970; Dwyer, 1972; Young, 1973; Berry, 1974; Galbraith, et al., 1975) which concluded that the increased attention, motivation, preference, code switching, processing interference or rehearsal with accompanying physiological changes associated with the use of color may be detrimental or produce no significant achievement effects unless appropriate pacing or time is allotted. It is this quality and quantity of interactive time which has been suggested as the most important of all learning variables (Bloom, 1974).

It should be noted that in this (Lamberski & Myers, 1980) and in previous studies (Lamberski, 1980a; Lamberski & Roberts, 1979), a wide range between individual students was noted for processing time on instruction and task tests suggesting further replication or extension of the interactive materials themselves.

In Conclusion

The purpose of this review was to provide evidence of the effect of color cueing and coding on instruction and test materials. Specifically the studies, categorized and presented within selected interrelated criteria, were intended to provide a literature framework for future investigations. Weaknesses of past research have been a limited survey of the literature and a lack of conceptualization of the interrelated variables which determine color's effectiveness. These weaknesses were usually found reflected in the use of biased experimental materials or in the use of inappropriate research design methodology to control or explain these biases. However, given the vastness of the literature base, several conclusions may be derived. The reader is encouraged, since these conclusions are derived acrossed the categorized criteria, to refer back to the specific literature for more detailed descriptions of the research findings.

The instructional value of color appears highly dependent upon the complexity of the task in the materials and perceived response requirements by the learner. It is known that color is preferred in learning materials and can be used to focus attention and provide motivation. Furthermore, color has been shown to have a physiological basis in the coding of perceptual stimuli. This color advantage has particularly been shown to facilitate discrimination in perceptual situations where complexity or quantity may preclude the use of other cues.

Color was found to be of value in non-meaningful tasks, especially if other perceptual cues lacked physical form differences or were low in associative value. The application of color to meaningful tasks appeared related to the interaction between learner and materials. In externally paced materials (passive), color appeared to be secondary to other salient features. If the task in passive materials became confusing, especially in simultaneous audio and visual materials, the learner selectively attended to a preferred mode as the functional stimulus; in most adult learners this preferred mode is verbal though in some incidences an integrated verbal and visual strategy may be utilized. Thus, _if_ color was central to concept instruction, and _if_ it was selected, color facilitated learning.

The literature surveyed also reinforces that unless structuring strategies like color were perceived to be or told to be important, the learner may have filtered out relevant information. Thus, in unstructured situations, older learners are found to be in a highly favorable position to learn from purely auditory or print materials negating the relevant visual code. In structured situations, however, older learners appeared to have the encoding and rehearsal strategies necessary to use an integrated code system like color. Younger learners generally have been found to benefit from color cues in passive materials due more to motivational than identified cognitive functions.

Color codes have been found to be ineffective in passive materials, apparently due to insufficient learner-material interactive time. However, color codes have had more success in facilitating verbal (reading and phonic) performance in self-paced materials (active) and recently their application to more complex cognitive learning has been evidenced in the literature.

The value of color in retrieval tasks again appears highly task related. Color cues appeared to facilitate recall of low perceptual tasks which were highly visual, while the facilitating value of color cues in more verbal tasks was not supported. However, color codes have been found to facilitate achievement in complex cognitive self-paced tasks, particularly with the more visually requiring tasks.

It has also been stated that color should inhibit forgetting, particularly when an immediate post-instruction test is administered.

However, there is research which suggests that the value of color in testing materials is only for low perceptual tasks, having no significant effect in more complex tasks.

The relationship of color to time remains unclear; at best the relationship was dependent upon complexity of the perceptual task, selected code strategy, and required response. Color may reduce time in low perceptual tasks depending on limited or umlimited time given to the learner; but the relationship of color in more complex tasks is highly dependent on the interrelatedness of several variables. Hock and Egeth (1970), speaking on time in complex color-word interference tasks, suggested that increased time for color "... should appear in tasks which involve the cognitive apparatus rather than in 'low-level' perceptual tasks" (p. 302). This appears supported for concept acquisition but findings for concept retrieval are still in need of further investigation.

Lastly new methods such as efficiency analysis or certain learner aptitudes (Chute, 1979) appear to offer design methodology which may further explain the cognitive functioning and processing of color stimuli. However, the base of this research needs further expansion and replication.

REFERENCES

Adkinson, C. D., & Berg, W. K. Cardiac deceleration in newborns: habituation, dishabituation, and offset responses. *Journal of Experimental Child Psychology*, 1976, *21*(1), 46-60.

Allington, R. L. An evaluation of the use of color cues to focus attention in discrimination and paired-associate learning (Doctoral dissertation, Michigan State University, 1973). *Dissertation Abstracts International*, 1973, *34*(06), 3127A. (University Microfilms No. 73-29658)

Ambler, B. A., & Proctor, R. W. Rod involvement in peripheral color processing. *Scandinavian Journal of Psychology*, 1976, *17*(2), 142-148.

Arnold, P. G., & Bower, G. H. Perceptual conditions affecting ease of association. *Journal of Experimental Psychology*, 1972, *93*(1), 176-180.

Bannatyne, A. D. The color phonics system. In J. Money (Ed.), *The Disabled Reader*. Baltimore: The Johns Hopkins Press, 1966.

Berry, F. M. Paired-associate learning of normal children and retardates relevant redundant compound stimuli (Doctoral dissertations, University of Alabama, 1969). *Dissertation Abstracts International*, 1970, *30*(8), 3884B. (University Microfilms No. 70-1366)

Berry, L. H. An exploratory study of the relative effectiveness of realistic and non-realistic color in visual instructional materials (Doctoral dissertation, The Pennsylvania State University, 1974). *Dissertation Abstracts International*, 1975, *35*(12), 7717A. (University Microfilms No. 75-10787)

Berry, L. H. *The effects of color realism on pictorial recognition memory*. A paper presented at the Annual Convention of the Association for Educational Communications and Technology. Miami Beach, FL, 1977.

Billmeyer, F. W. (Ed.). *Color Research and Application*. New York: John Wiley and Sons, 1977.

Birren, F. The effects of color on the human organism. *American Journal of Occupational Therapy*, 1959, *13*, 125-129.

Birren, F. *Color--A Survey in Words and Pictures*. New Hyde Park: University Books, Inc., 1963.

Bloom, B. S. Time and learning. *American Psychologist*, 1974, *29*, 682-688.

Booth, G. D. The comparitive effectiveness of monochrome and color presentations in the facilitation of affective learning (Doctoral dissertation, University of Southern California, 1971). Dissertation Abstracts International, 1972, 32(7), 3855A. (University Microfilms No. 72-3758)

Bornstein, M. H. Hue is an absolute code for young children. Nature, 1975, 256, 309-310.

Bornstein, M. H., Kessen, W., & Weiskopf, S. The categories of hue in infancy. Science, 1976, 191, 201-202.

Bourne, L. E., & Restle, F. Mathematical theory of concept identification. Psychological Review, 1959, 66, 278-296.

Bower, G. H. Perceptual groups as coding units in immediate memory. Psychonomic Science, 1972, 27(4), 217-219.

Bretz, R. Colour TV in instruction. Educational Technology, 1971, 11(7), 51-53.

Brown, J. L. Visual elements in flight simulation (Technical Report 73-2). Rochester, New York: Center for Visual Science, Rochester University, 1973.

Buchanan, J. P. Cue salience as an indicator of developmental changes in the flexibility of the preattentive and focal attentional systems (Doctoral dissertation, University of California at Los Angeles, 1975). Dissertation Abstracts International, 1975 36(02), 931B. (University Microfilms No. 75-17800)

Caban, J. P. Eye movement preferences as individual differences in learning from color and non-color pictures (Doctoral dissertation, University of Massachusetts, 1971). Dissertation Abstracts International, 1972, 32(12), 6805A. (University Microfilms No. 72-18258)

Carterette, E. C., & Friedman, M. P. (Eds.). Handbook of Perception, Volume 5--Seeing. New York: Academic Press, 1975.

Casey, R. J., Jr. The cognitive effectiveness of color and monochrome educational materials with elementary school children (Doctoral dissertation, University of Southern California at Los Angeles, 1972). Dissertation Abstracts International, 1973, 33(03), 1072A. (University Microfilms No. 72-23141)

Chan, A., Travers, R. W., & VanModfrans, A. The effect of colored embellishment of visual array on a simultaneously presented audio array. AV Communication Review, 1965, 13, 159-165.

Cheskin, L. Colors: What They Can Do For You. New York: Liveright Publishing Corporation, 1948.

Child, I. L. Age and sex differences in children's color preferences. Child Development, 1968, 39, 237-247.

Christ, R. E. Review and analysis of color coding research for visual displays. Human Factors, 1975, 17(6), 542-570.

Chu, G. C., & Schramm, W. Learning from Television: What the Research Says. Washington, D.C.: National Association of Educational Broadcasters, 1967.

Chute, A. G. An experimental study investigating the comparative effectiveness of a color and a monochrome version of an instructional film presentation on incidental and task-relevant discrimination learning (Doctoral dissertation, University of Wisconsin at Madison, 1978). Dissertation Abstracts International, 1979, 39(01), 74A. (University Microfilms No. 78-06414)

Chute, A. G. Analysis of the instructional functions of color and monochrome cuing in media presentations. Educational Communication and Technology Journal, 1979, 27(4), 251-263.

Collier, R. E. Factors related to children's expressed color preferences at selected grade levels (Doctoral dissertation, Syracuse University, 1957). Dissertation Abstracts, 1958, 19(5), 985. (University Microfilms No. 20817)

Committee on Colorimetry. The Science of Color. New York: Thomas Y. Crowell Co., 1954.

Corballis, M. C., & Luthe, L. Two-channel visual memory. Perception and Psychophysics, 1971, 9(4), 361-367.

Crowder, R. G. Principles of Learning and Memory. New York: John Wiley and Sons, 1976.

Cruickshank, W. M. The Brain-Injured Child in Home, School and Community. Syracuse: Syracuse University Press, 1967.

Daehler, M., Bukatko, D., Benson, K., & Myers, N. The effects of size and color cues on the delayed response of very young children. Bulletin of the Psychonomic Society, 1976, 7(1), 65-68.

Daehler, M. W., Horowitz, A. B., Wynns, F. C., & Flavell, J. H. Verbal and nonverbal rehearsal in children's recall. Child Development, 1969, 40(2), 443-452.

Daniel, P. N., & Tacker, R. S. Preferred modality of stimulus input and memory for CVC trigrams. Journal of Educational Research, 1974, 67(6), 255-258.

Davis, P. Eye movement preferences as predictors of differential success from color vs. monochrome associative learning materials (Doctoral dissertation, University of Massachusetts, 1975). Dissertation Abstracts International, 1976, 36(09), 5649A. (University Microfilms No. 76-05327)

Deich, R. F. Color recognition and word frequency. *American Journal of Psychology*, 1972, *85*(3), 393-396.

DeLucia, F. S. Comparative effectiveness of monochrome and color presentations in the facilitation of affective learning by low-income black elementary school pupils (Doctoral dissertation, University of Southern California, 1975). *Dissertation Abstracts International*, 1975, *35*(09), 5673A. (University Microfilms No. 75-6408)

Denis, M. Test of the incidental-cues hypothesis. *Perceptual and Motor Skills*, 1976, *43*(1), 175-178.

Deutschmann, P. J., Barrow, L. C., Jr., & McMillan, A. Efficiency of different modes of communication. *AV Communication Review*, 1961, *9*, 263-270.

Dooley, R. P., & Harkins, L. E. Functional and attention-getting effects of color on graphic communications. *Perceptual and Motor Skills*, 1970, *31*, 851-854.

Dulsky, S. G. The effect of a change of background on recall and learning. *Journal of Experimental Psychology*, 1935, *18*, 725-740.

Dwyer, F. M., Jr. *A Guide for Improving Visualized Instruction*. State College, PA: Learning Services, 1972.

Dwyer, F. M., Jr. Effects of IQ level on the instructional effectiveness of black and white and color illustrations. *AV Communication Review*, 1976a, *24*, 49-62.

Dwyer, F. M., Jr. *Practical considerations in using visualized materials in the instructional development process*. A paper presented at the Annual Convention of the International Visual Literacy Association. Nashville, TN, 1976b.

Dwyer, F. M., Jr. *Strategies for Improving Visual Learning*. State College, PA: Learning Services, 1978.

Dyer, F. N. *The Stroop phenomenon and its use in the study of perceptual cognitive and response processes*. Army Medical Research Lab, 1972. (ERIC Document Reproduction Service No. ED 071 032)

English, M. D. A comparison of the influence of colored as opposed to black and white instructional materials on the acquisition of learning (Doctoral dissertation, University of Wisconsin at Madison, 1961). *Dissertation Abstracts*, 1961, *22*(6), 1919. (University Microfilms No. 61-6212)

Ernest, C. H., & Paivio, A. Imagery and sex differences in incidental recall. *British Journal of Psychology*, 1971, *62*(1), 67-72.

Estes, W. K. (Ed.). Handbook of Learning and Cognitive Processes: Volume 4--Attention and Memory. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc., 1976.

Farley, F. H., & Grant, A. P. Arousal and cognition: memory for color versus black and white multimedia presentation. Journal of Psychology, 1976, 94(1), 147-150.

Farr, B. J. Individual differences in learning: predicting one's more effective learning modality (Doctoral dissertation, Catholic University of America, 1971). Dissertation Abstracts International. 1971, 32(3), 1332A. (University Microfilms No. 71-20355)

Field, H. H. The effect of color versus black and white instructional television on student attitude toward the subject matter and retention of the subject matter (Doctoral dissertation, University of Maryland, 1972). Dissertation Abstracts International, 1972, 33(05), 1973A. (University Microfilms No. 72-28892)

Flemming, M. L., & Sheikhian, M. Influence of pictorial attributes on recognition memory. AV Communication Review, 1972, 20(4), 423-441.

Frechtling, J. A. Situational determinants of color-form salience in matching and learning tasks (Doctoral dissertation, The George Washington University, 1970). Dissertation Abstracts International, 1970, 31(07), 4360B. (University Microfilms No. 70-27071)

Freed, D. W. Variables in self-instruction materials designed to teach the operation of audio-visual equipment (Doctoral dissertation, The Pennsylvania State University, 1963). Dissertation Abstracts, 1964, 24(8), 3227. (University Microfilms No. 64-1392)

Funkhouse, G. R. Effects of differential encoding on recall. Journal of Verbal Learning and Verbal Behavior, 1968, 7(6), 1016-1023.

Galbraith, G. C., Hohmann, A., & Creutzfeldt, O. D. Correlation between the chromatic visual evoked response and McCollough aftereffect. Psychophysiology, 1975, 12(6) 667-672.

Gardiner, J. M., Klee, H., Redman, G., & Ball, M. The role of stimulus material in determining release from proactive inhibition. Quarterly Journal of Experimental Psychology, 1976, 28(3), 395-402.

Gattegno, C. Words in Color: Background and Principles. Chicago: Encyclopedia Britannica Press, 1962.

Geis, M. F. A developmental study of category, rhyme, and color encoding in a release-from-proactive-interference paradigm (Doctoral dissertation, Emory University, 1974). Dissertation Abstracts International, 1975, 35(07), 3611B. (University Microfilms No. 75-1878)

Gerard, R. Color and emotional arousal. American Psychologist, 1958, 13, 340.

Gibson, J. J. Motion picture testing and research (Report No. 7). Army Air Forces Aviation Psychology Program, Washington, D.C.: U. S. Government Printing Office, 1947.

Goldstein, K. Some experimental observations concerning the influence of color on the function of the organism. Occupational Therapy, 1942, 21, 147-151.

Goodman, M. D. The rate of learning colored vs. black letters with elementary school children (Doctoral dissertation, Brigham Young University, 1975). Dissertation Abstracts International, 1975, 35(05), 2428B. (University Microfilms No. 74-24553)

Goodman, M. D., & Cundick, B. P. Learning rates with black and colored letters. Journal of Learning Disabilities, 1976, 9(9), 600-602.

Gordon, M. C., Gordon, A., & Perrier, C. Stimulus presentation rate and level of intellectual competency. Psychonomic Science, 1967, 8(10), 403-404.

Gottlieb, W., & Lindauer, M. S. The effect of contextual stimuli on retroactive inhibition. Psychonomic Science, 1967, 9(6), 331-332.

Gropper, G. L. A behavioral perspective on media selection. AV Communication Review, 1976, 24(2), 157-186.

Hale, G. A., & Green, R. Z. Children's attention to stimulus components with variation in relative salience of components and degree of stimulus integration. Journal of Experimental Child Psychology, 1976, 21(3), 446-459.

Hale, G. A., & Taweel, S. S. Children's component selection with varying degrees of training. Princeton, NJ: Educational Testing Service, 1972. (ERIC Document Reproduction Service No. ED 066 213)

Harris, D. H., Kolesnik, P. E., & Teal, K. S. Wire sorting performance with color and number coded wires. Human Factors, 1964, 5(2), 127-131.

Harrison, N. A., & Boese, E. The locus of semantic interference in the Stroop color-naming task. Perception and Psychophysics, 1976, 20(5), 408-412.

Hinds, L. R., & Dodds, W. Words in color: two experimental studies. Journal of Typographic Research, 1968, 2(1), 43-56.

Hoban, C. F. The state of the art of film in instruction: a second look. *Audio-Visual Instruction*, 1975, *20*(4), 30-34.

Hoban, C. F., & VanOrmer, E. B. *Instructional Film Research, 1918-1950* (Technical Report No. SDC 269-7-19). Instructional Film Research Program, The Pennsylvania State College, Port Washington, New York: U. S. Naval Special Devices Center, 1950.

Hochberg, J. Perception I. Color and shape. In J. W. Kling and L. A. Riggs (Eds.), *Woodworth and Schlosberg's Experimental Psychology* (3rd edition). New York: Holt, Rinehart and Winston, 1971.

Hock, H. S., & Egeth, H. Verbal interference with encoding in a perceptual classification task. *Journal of Experimental Psychology*, 1970, *83*(2), 299-303.

Hudson, W. Color versus monochrome in a demonstration film used to administer performance tests for the classification of African workers. *Journal of National Institute of Personnel Research*, Johannesburg, South Africa, 1958.

Ibison, R. A. *Differential effects on the recall of textual materials associated with the inclusion of colored and uncolored illustrations*. Unpublished doctoral dissertation, Indiana University, Bloomington, 1952.

Ingersoll, G. M. The effects of presentation modalities and modality preferences on learning and recall (Doctoral dissertation, The Pennsylvania State University, 1970). *Dissertation Abstracts International*, 1971, *32*(1), 240A. (University Microfilms No. 71-16615)

Isaacs, D. L. *Cue selection in paired associate learning as a function of relevance of color cues and discriminability of shape cues*. Unpublished master's thesis, Indiana University, 1966.

Isaacs, D. L. The effect on learning of the color coding of pictorial stimuli (Doctoral dissertation, Indiana University, 1969). *Dissertation Abstracts International*, 1970, *30*(11), 5257B. (University Microfilms No. 70=07462)

Jones, J. K. Colour as an aid to visual perception in early reading. *British Journal of Educational Psychology*, 1965, *35*, 21-27.

Jones, J. K. A research report on colour story reading. *Journal of Typographic Research*, 1968, *2*(1), 53-58.

Jones, M. R. Color coding. *Human Factors*, 1962, *4*(6), 355-365.

Kalin, M. The influence of choice on the acquisition and retention of learning materials in different modes of instruction (Doctoral dissertation, West Virginia University, 1972). *Dissertation Abstracts International*, 1973, *33*(11), 5973A. (University Microfilms No. 73-12942)

Kanner, J. H. *The instructional effectiveness of color in television: a review of the evidence*. Department of the Army, Office of the Assistant Chief of Staff for Communications-Electronics, Washington, D.C., 1968. (ERIC Document Reproduction Service No. ED 015 675)

Kanner, J. H., & Rosenstein, A. Television in army training: color vs. black and white. *AV Communication Review*, 1960, *8*(6), 243-252.

Kauffman, S. P., & Dwyer, F. M. Effectiveness of cartoons and photographs in in-service training. *California Journal of Educational Research*, 1974, *25*(4), 197-204.

Kaneko, T. Color broadcasting--a note on its educational effects. *Educational Broadcasting International*, 1971, *5*(4), 281.

Katzman, N., & Nyenhuis, J. Color versus black and white effects on learning, opinion and attention. *AV Communication Review*, 1972, *20*(1), 16-28.

Kauffman, S.P. *An experimental evaluation of the relative effectiveness of cartoons and realistic photographs in both color and black and white visuals in in-service training programs*. Unpublished master's thesis, The Pennsylvania State University, 1973.

Knafle, J. D. Color cues in word perception. *Journal of Reading Behavior*, 1974, *6*(3), 233-247.

Kouwer, B. *Colors and Their Character*. The Hague: Martinius Nijhoff, 1949.

Kumata, H. A decade of teaching by television. In W. Schramm (Ed.), *The Impact of Educational Television*. Illinois: University of Illinois Press, 1960, 176-194.

Lamberski, R. J. *An exploratory investigation on the instructional effect of color and black and white cueing on immediate and delayed retention*. Unpublished master's thesis, The Pennsylvania State University, 1972.

Lamberski, R. J. *An exploratory study in maximizing retention by utilizing black/white and color coding in visualized instruction*. A paper presented at the Annual Convention of the Association for Educational Communications and Technology. Dallas, TX, 1975.

Lamberski, R. J. *The effect of a verbal and visual color code on self-paced instruction and testing for retention on different tasks*. Unpublished doctoral dissertation, The Pennsylvania State University, 1980 a.

Lamberski, R. J. *The achievement effect of a color or black/white code in learning and test materials*. A paper presented at the Annual Convention of the American Educational Research Association, Boston, MA, 1980 b.

Lamberski, R. J., & Myers, B. E. The efficiency of a color or black/white code in learning and test materials. A paper presented at the Annual Convention of the American Educational Research Association, Boston, MA, 1980.

Lamberski, R. J., & Roberts, D. M. Efficiency of student's achievement using black/white and color coded learning and test materials. A paper presented at the Annual Convention of the Association for Educational Communications and Technology, New Orleans, LA, 1979. (ERIC Document Reproduction Service No. ED 172 800)

Land, E. H. The retinex theory of color vision. Scientific American, 1977, 237(10), 108-120.

Light, L. L., Berger, D. E., & Bardales, M. Trade-off between memory for verbal items and their visual attributes. Journal of Experimental Psychology: Human Learning and Memory, 1975, 104(2), 188-193.

Lilly, M. S., & Kelleher, J. Modality strengths and aptitude-treatment interaction. Journal of Special Education, 1973, 7, 5-13.

Link, J. D. A comparison of the effects on learning of viewing films in colour on a screen and in black and white over closed circuit television. Ontario Journal of Educational Research, 1961, 3(2), 111-115.

Logan, G. D. Selective visual processing with tilt and color cues. Bulletin of the Psychonomic Society, 1976, 8(6), 463-465.

Long, A. L. The use of color on acquisition and retention as evidenced by sound films. Unpublished doctoral dissertation, University of Colorado, 1946.

Lumsdaine, A. A. Instruments and media of instruction. In N. L. Gage (Ed.), Handbook of Research on Teaching. Chicago: Rand-McNally, 1963, 583-682.

Luria, S. M., & Strauss, M. S. Eye movements during search for coded and uncoded targets. Perception and Psychophysics, 1975, 17(3), 303-308.

Lyczak, R. A. Learning to read: the redundant cues approach. Journal of Educational Psychology, 1976, 68(2), 157-166.

MacLean, W. P. A comparison of colored and uncolored pictures. Educational Screen, 1930, 9, 196-199.

Majeres, R. L. Cognitive control and learning: interactive effects of cognitive control, motivation, and cue selection in color-word paired-associate learning (Doctoral dissertation, University of Nebraska, 1970). Dissertation Abstracts International, 1971, 31(8), 5031B. (University Microfilms No. 71-2907)

Malter, M. S. Children's preferences for illustrative materials. Journal of Educational Research, 1948, 41, 384-385.

Martin, D. W., & Richards, E. Locus of selectivity in a visual memory task using a color value indicator. Perception and Psychophysics, 1972, 12(1), 65-68.

May, M. A., & Lumsdaine, A. A. (Eds.). Learning from Films. New Haven, CT: Yale University Press, 1958.

Meyer, G. E. A psychophysical investigation of human cortical color coding neural units (Doctoral dissertation, State University of New York at Buffalo, 1975). Dissertation Abstracts International, 1976, 36(10), 5310B. (University Microfilms No. 76-09089)

Miller, O. R. An investigation of the cognitive effectiveness of color and monochrome presentations with Black elementary school children in relation to the predominant home television viewing mode (Doctoral dissertation, University of Southern California, 1972). Dissertation Abstracts International, 1974, 34(11), 6950A. (University Microfilms No. 74-11695)

Moore, P. Bibliography: a listing of recommended books on vision. Photomethods, 1977, 20(10), 56.

Murch, G. M. Color contingent motion aftereffects: single or multiple levels of processing. Vision Research, 1974, 14(11), 1181-1184.

Nealis, P. M. Reversal of Stroop test: interference in word reading. Perceptual and Motor Skills, 1974, 38(2), 379-382.

Newby, R. W., & Young, R. K. Percentage of occurrence of correct response and implicit associative responses in verbal discrimination learning. Journal of Experimental Psychology, 1972, 96(1) 49-53.

Nielsen, G. D. The locus and mechanism of the Stroop color word effect (Doctoral dissertation, University of Wisconsin at Madison, 1975). Dissertation Abstracts International, 1975, 35(11), 5672B. (University Microfilms No. 75-5942)

Norman, C., & Rieber, M. Facilitation of concept formation in children by the use of color cues. Journal of Experimental Psychology, 1968, 76, 460-463.

Nourse, J. C., & Welch, R. B. Emotional attributes of color: a comparison of violet and green. Perceptual and Motor Skills, 1971, 32, 403-406.

O'Brien, T. G. Cue selection and mediation of color versus verbal stimuli among third-graders, fifth graders and seventh graders (Doctoral dissertation, Saint Louis University, 1971). Dissertation Abstracts International, 1973, 33(03), 1272B. (University Microfilms No. 72-23987)

O'Connor, P. J. A comparison of three forms of AV presentation in general science lessons. Graduate Research in Education and Related Disciplines, 1970, 6(1), 67-82.

Otto, W., & Askov, E. The role of color in learning and instruction. *Journal of Special Education*, 1968, *2*, 155-165.

Parks, B. *Color Theory: Selected Bibliography* (Exchange Bibliography #886). Illinois: Council of Planning Librarians, 1975.

Parks, B., & Architecture, M. *Psychological Response to Surface Color* (Exchange Bibliography #902). Illinois: Council of Planning Librarians, 1975.

Peterson, L. R., & Peterson, M. J. The role of context stimuli in verbal learning. *Journal of Experimental Psychology*, 1957, *53*, 102-105.

Petrich, J. A., & Chiesi, H. L. The locus of color-context changes, encoding instructions, and their effect on retroactive inhibition. *Journal of Experimental Psychology: Human Learning and Memory*, 1976, *2*(2), 190-199.

Plack, J. J., & Shick, J. The effects of color on human behavior. *Journal of the Association for the Study of Perception*, 1974, *9*(1), 4-16.

Powers, G. F., & Shrader, K. B. The value of color in pharmaceutical education. *Educational and Industrial Television*, 1975, *7*(7), 20-21.

Puig, J. A. *Requirements for color in television displays* (Final Report for Period September 1975-June 1976). Naval Air Systems Command, Washington, D.C., 1976. (ERIC Document Reproduction Service No. ED 125 606)

Randel, J. M., Havrda, C. Associative strength over time of first and second list responses in color context. *Psychonomic Science*, 1968, *13*(2), 117-118.

Reich, C., & Meisner, A. A comparison of colour and black and white TV. *AV Communication Review*, 1973, *21*, 489.

Rosenheim, E. On color perception and affect (Doctoral dissertation, Boston University, 1967). *Dissertation Abstracts*, 1967, *28*(5), 2148B. (University Microfilms No. 67-13264)

Rosenstein, A. J., & Kanner, J. H. Television in Army training: color vs. black and white. Part II. *AV Communication Review*, 1961, *9*, 44-49.

Rudisill, M. Children's preferences for color versus other qualities in illustrations. *The Elementary School Journal*, 1952, *52*, 444-451.

Rudnick, M. F. The attention-getting effects of color and monochrome photographs of sixth grade students with differing perceptual styles (Doctoral dissertation, Indiana University, 1974). *Dissertation Abstracts International*, 1975, *35*(9), 5938A. (University Microfilms No. 75-05660)

Rudnick, M. F., Porter, M. C., & Suydam, E. L. Pictorial stimulus variables. *Viewpoints*, School of Education, Indiana University, 1973, *49*(2), 21-28.

Rust, G. C. *A study to explore the effectiveness of color photographs in intrinsically programmed automated instructional materials* (Final Report). Carbondale: Southern Illinois University, 1967.

Sabo, R. A., & Hagen, J. W. Color cues and rehearsal in short-term memory. *Child Development*, 1973, *44*(1), 77-82.

Saltz, E. Compound stimuli in verbal learning: cognitive and sensory differentiation versus stimulus selection. *Journal of Experimental Psychology*, 1963, *66*(1), 1-5.

Samuels, S. J. Relationship between formal intra-list similarity and magnitude of the Von Restorff effect. *Proceedings of the 75th Annual Convention of the American Psychological Association*, 1967, *2*, 277-278.

Sato, S. Children's incidental learning and selective attention: effects of the number of times of presentation trials and the color as a cue property. *Japanese Journal of Psychology*, 1976, *47*(5), 250-257.

Scarpino, T. F. The comparative effect of two strategies--color versus black and white on achievement in college physical science (Doctoral dissertation, The Pennsylvania State University, 1972). *Dissertation Abstracts International*, 1972, *32*(11), 6222A. (University Microfilms No. 72-13927)

Schaps, E., & Guest, L. Some pros and cons of colour TV. *Journal of Advertising Research*, 1968, *8*(2), 28-32; 36-39.

Schioldberg, B., Paus, E., & Myhre, G. Effect of task, selection set, and dispersion of attention on visual identification time. *Scandinavian Journal of Psychology*, 1973, *14*(3), 195-198.

Schontz, W. D., Trumm, G. A., & Williams, L. G. Color coding for information location. *Human Factors*, 1971, *13*(3), 237-246.

Schramm, W. L. (Ed.). *Quality in Instructional Television*. Honolulu: University Press of Hawaii, 1972.

Schwartz, A. M. The effects of conditioning upon children's color choices and color usage (Doctoral dissertation, The Pennsylvania State University, 1960). *Dissertation Abstracts*, 1960, *21*(1), 128. (L. C. Card No. Mic 60-2171)

Schweitzer, H. C. Comparison of color and black and white films in the modification of attitudes (Doctoral dissertation, Fordham University, 1963). *Dissertation Abstracts*, 1963, *24*(2), 874. (University Microfilms No. 63-5602)

Schwerin, H. S. Impact of color TV commercials. *RCA Broadcast News*, 1957, *96*, 31-35.

Scull, C. R. Instructional effectiveness of two types of visual illustrations in facilitating specific geographic learning at the college level (Doctoral dissertation, The Pennsylvania State University, 1974). Dissertation Abstracts International, 1975, 35(11), 7038A. (University Microfilms No. 75-9838)

Shaw, D. W., III. Comparative analysis of color versus non-color in accelerating learning of technical engineering graphics line and plane analyses (Doctoral dissertation, East Texas State University, 1975). Dissertation Abstracts International, 1976, 36(11), 7137A. (University Microfilms No. 76-11953)

Sheppard, J. J., Jr. Human Color Perception--A Critical Study of the Experimental Foundation. New York: Elsevier, 1968.

Smith, R. S. An investigation of the relationship between physiological and cognitive measures to the affective response to color (Doctoral dissertation, University of Pennsylvania, 1958). Dissertation Abstracts, 1958, 19(4), 873. (L. C. Card No. Mic 58-3373)

Spangenberg, R. Which is better for learning? Color or black and white? Audio-Visual Instruction, 1976, 80.

Spears, R. E. The effects of color versus black and white television on learning for college students with auditory or visual modality preference (Doctoral dissertation, East Texas State University, 1976). Dissertation Abstracts International, 1976, 37(05), 2588A. (University Microfilms No. 76-24541)

Swede, G., & McNulty, J. A. The influence of contextual cues upon the learning and retention of paired associates. Canadian Journal of Psychology, 1967, 21(5), 394-408.

Tolliver, D. L. A study of color in instructional materials and its effects upon learning (Doctoral dissertation, Purdue University, 1970). Dissertation Abstracts International, 1971, 31(8), 3976A. (University Microfilms No. 71-2700)

Travers, R. M. W. A study of the advantages and disadvantages of using simplified visual presentations in instructional materials. U. S. Office of Education (DHEW), Washington, D.C., Bureau of Research, 1969.

Travers, R. M. W. Man's Information System. Scranton, PA: Chandler Publishing Company, 1970.

Travers, R. M. W., Chan, A., & VanMondfrans, A. P. The effect of colored embellishments of a visual array on a simultaneously presented audio array. AV Communications Review, 1965, 13, 159-164.

Travers, R. M. W., McCormick, M. C., VanMondfrans, A., & Williams, F. E. Research and theory related to audiovisual information transmission. Utah: Bureau of Educational Research, University of Utah, 1964.

Underwood, B. J., & Freund, J. S. Further studies on conceptual similarity in free-recall learning. Journal of Verbal Learning and Verbal Behavior, 1969, 8(1), 30-35.

Underwood, B. J., Ham, M., & Ekstrand, B. Cue selection in paired-associate learning. Journal of Experimental Psychology, 1962, 64, 405-409.

VanBuskirk, W. L. An experimental study of vividness in learning and retention. Journal of Experimental Psychology, 1932, 15, 563-573.

VanderMeer, A. W. Relative effectiveness of instruction by film exclusively, films plus study guides, and standard lecture methods (Technical Report, SDC-269-7-13). Special Devices Center, Office of Naval Research, Port Washington, New York, 1949.

VanderMeer, A. W. Relative effectiveness of color and black and white in instructional films (Technical Report, SDC-269-7-28). Special Devices Center, Office of Naval Research, Port Washington: New York, 1952.

VanderMeer, A. W. Color vs. black and white in instructional films. AV Communication Review, 1954, 2(2), 121-134.

Vidyasagar, T. R. Orientation specific colour adaptation at a binocular site. Nature, 1976, 261, 39-40.

Vollan, C. J. Effects of black and white, authentic and contrived color on children's perceptions of dynamic picture content (Doctoral dissertation, University of Washington, 1971). Dissertation Abstracts International, 1972, 32(08), 4435A. (University Microfilms No. 72-07427)

Washington, E. D. Matching and naming letters of the alphabet with and without redundant color cues (Doctoral Dissertation, University of Illinois, 1968). Dissertation Abstracts, 1968, 29(2), 490. (University Microfilms No. 68-12218)

Weiss, W., & Margolius, G. The effect of context stimuli on learning and retention. Journal of Experimental Psychology, 1954, 48, 318-322.

Wicker, F. W. Photographs, drawings, and nouns as stimuli in paired-associate learning. Psychonomic Science, 1970, 18(4), 205-206.

Winn, W. D. The structure of multiple free associations towards black and white pictures and color pictures. AV Communication Review, 1976, 24, 273-293.

Winn, W. D. The effect of the removal of common meaning on the structure of free associations to black and white and color pictures. A paper presented at the Annual Convention of the Association for Educational Communications and Technology. Miami Beach, FL, 1977.

Young, R. A. The perception of color with temporal pulse-count coding of electrical stimuli applied to the eye (Doctoral dissertation, New York University, 1973). Dissertation Abstracts International, 1974, 34(08), 4103B. (University Microfilms No. 74-01987)

Yurkiw, L. N., & Gounard, B. R. Color and noun imagery in free recall. Psychological Reports, 1975, 37(1), 318.

Zuckerman, J. V. Predicting film learning by prerelease testing. AV Communication Review, 1954, 2, 49-56.

TITLE: Visual Instructional Strategies and
Cognitive Style

AUTHOR: A. Arvo Leps

VISUAL INSTRUCTIONAL STRATEGIES AND COGNITIVE STYLE

A. Arvo Leps
California State University,
Northridge

INTRODUCTION

This research* endeavored to develop and evaluate instructional materials that would match the needs of learners identified as "holistic" in their learning preference. Thus, the study followed the aptitude-treatment interaction format to assess possible match/mismatch situations between learner variables and instructional variables. The research hypothesis was that matching learner preferences (herein termed as either "holistic" or "serialistic") with instructional treatment configurations (herein termed "non-linear" and "linear," respectively) would yield better performance than would the corresponding mismatch conditions, and would do so at a statistically significant level.

RATIONALE

This study was prompted by several concerns: first, to improve learning, cognitive style literature has been exhorting the instructional design community to identify and develop materials to match the various learning styles; second, hemisphericity research which derives from studies of the "split brain" and has repeatedly drawn elusive parallels to cognitive style, as well as research on "appositionality" (Bogen, 1969) have both indicated that many complex aspects of visual learning may reside in that right-hemispheric "appositionality;" third, learning from so-called non-linear visual presentations (Allen & Cooney, 1963) is being more-and-more thought of as a powerful tool for informing viewers and has consequently led to the blossoming of the multi-image presentation industry, even though little in the way of concrete demonstration of its instructional strengths has been shown since Brydon's 1972 study; and fourth, studying these questions seemed amenable to an experimental design that would follow the aptitude-treatment interaction model with which the researcher wanted to experiment, using the stepwise multiple regression analysis technique (recommended for such research by Cronbach & Snow, 1977) and which is readily analyzable using the SPSS computerized statistical analysis package.

Various informal sources also suggested that this same non-linear presentation technique might turn out to provide a match for holistic learners (e.g., salesmen, who are viewed as essentially holistic problem solvers seem exceptionally open to multi-image presentations and the simultaneity ascribed to holistic processing is certainly an integral component in the conceptualization of multi-imagery). Consequently this type of match was considered as a proper research vehicle.

---

* The work reported herein represents a part of a study conducted for the doctoral dissertation submitted to the Graduate School of Education, University of California, Los Angeles.

VARIABLES

The cognitive style question has been undergoing extensive investigation--especially as regards the field-dependence/independence duality (already under discussion at this meeting) and which the ETS-based group under the leadership of the late Herman Witkin (Witkin, Oltman, Cox, Ehrlichman, Hamm, & Ringler, 1973, and supplements in 1974 and 1976) has documented with over 2000 reports. This study also took into consideration the field-dependence/independence variables (although not by using the conventional measures, namely the rod-and-frame test or the Embedded-Figures Test) while also attempting to include the hemisphericity-based appositionality /propositionality (A/P) duality into the variable.

Bogen defined propositionality to include most of our conventional verbally-oriented, sequential types of learning, whereas the less obvious (because of its residing in the "silent hemisphere") appositionality includes various non-sequential or simultaneous, visual, gestalt-organization-oriented types of learning.

The measures of appositionality that have been used are the gestalt-closure tests (typically, the one designed by Street--and published in 1931--although others exist as well) wherein those that perform well on them are considered appositional. Those who do well on verbal or sequential-reasoning tasks are labelled as propositionals. Because the two capabilities are not mutually exclusive (because here two *different* tests are used, as compared to the field-dependence/independence variable which is based on one single test) individuals can--as regards appositionality/propositionality--enjoy either, both, or neither to varying degrees. This, in turn has led to the investigation of what appears as a more interesting appositionality/propositionality (or A/P) *ratio* which has resulted in some interesting studies (Bogen, DeZure, TenHouten, and Marsh, 1972 and Harshman, Crawford, and Hecht, 1976).

In this study the attempt was made to go even one step further and to look for an even more complex composite labelled "holistic" or non-linear learning preference versus a "serial" or linear preference which were to include field-dependence and independence in the ratio. (Thus, field-dependence, or rather its inverse, enters into the denominator of the new H/S ratio, since one can expect that field-independence and propositionality represent fairly identical learning abilities.) Consequently, three measures were used to identify the learners--these being: Gestalt Completion, Vocabulary, and Hidden Figures tests. All three were drawn from the ETS "Kit of Factor Referenced Cognitive Tests" after a pilot study indicated that other tests (which would have been somewhat more difficult to use) preferred by previous researchers, correlated well with the ETS measures (and appeared to asses the same qualities) and could consequently be omitted for the sake of simplicity.

The "treatments" that were developed to provide a match or a mismatch to the cognitive style ratios, were two instructional programs. Their differences derived from multi-image research. Both were pre-programmed tape-slide presentations that were specifically designed for this study. They provided accelerated overview introductions to the basics of photography. The linear version used a conventional "slide show" organization, whereas the non-linear version was executed in the style of single slide multi-imagery. That is, each consecutive slide represented a composite of from one to four individual slides, so copied onto one slide as to simulate a multi-projector, multi-screen presentation. The content, organization, and "crucial" images were the same in the two presentations. Both had about 158 slide changes--however, the multi-image version offered 250 different images as compared to the 158 in the conventional version. The multi-image, or non-linear, version ran about 33 minutes with a condensed, rapidly paced narration whereas the conventional, or linear, version ran 42 minutes with a more leisurely paced and somewhat more conversational narration. Thus, the non-linear presentation offered visual redundancy and simultaneity and the linear version verbal redundancy and relaxed pacing.

Another factor that the study included as independent variables were both the timing and the mode of testing for the learning resulting from the instructional treatment. Learning was measured with both immediate posttests as well as with delayed retention tests using two sets of counterbalanced tests in three modes: constructed response, multiple choice, and pictorial interpretation.

Lastly, it became apparent that (because of random assignment to the the two treatment groups) the inclusion of residual pretest scores as a covariable was logically necessary. Cutoff scores on the pretest were used to remove from the study those learners who were already familiar with the subject matter. However, it was apparent that performance averages below the cutoff level differed for the two groups and hence needed to be accounted for in the multiple regression analyses.

METHOD

An initial participating population of about 250 college students became reduced by attrition at several stages to a sample of 190 whichpretesting further reduced to the 150 who were available for analyzing the immediate posttest results with about 112 participants available for delayed retention test analysis. Participants provided some demographic and preference data and underwent pretesting for content familiarity. They then completed three measures, all drawn from the 1976 edition of the ETS "Kit of Factor Referenced Cognitive Tests," earlier versions of which were referred to as the "French Kit." The selected tests were: a) the Gestalt Completion Test (CS-1), both parts, b) the Extended Range Vocabulary Test (V-3), first part, and c) the Hidden Figures Test (CF-1), second part. Total testing time was thus about a half hour.

Next, the participants were randomly assigned to the two presentations, which were followed by the three-mode posttest packet that also included some affective inquiries. The posttest required about 20 minutes. Following a delay of some days, each particpant received a counterbalanced alternative form of the posttests and affective inquiries accompanied by questions regarding content-related activities during the interim.

The test results were scored, tabulated, and coded for computerized data processing using the multiple regression subprogram REGRESSION, available in "package form." This is documented in the second edition of the Statistical Package for Social Studies (SPSS). The REGRESSION program enables the hierarchical entering of the variables so as to account for the effects of all possible variables before one attempts to ascertain any interactions due exclusively to the aptitudes and treatments being investigated. To test for the presence or absence of statistically significant interactions, the variables were entered into the equations for each of the six outcome measures using the following order: a) performance on the covarying pretest (below cutoff point), b) performance scores on the various single (or combined) cognitive style measures, c) the treatment variable (coded as either "1" or "2"), and d) the various interaction constructs obtained by multiplication of the cognitive style outcomes with the treatment code. (For details on the analysis, cf. Kerlinger & Pedhazur, 1973.)

Thus, each of the three "modes," or measures of learning (either when used as immediate posttest or as delayed retention test) was evaluated in terms of the holistic/serialistic (S/H) ratio as well as in terms of performance on each of the component measures of cognitive style. The H/S ratio was derived from standardized "*T*-scores" computed from the gestalt completion (GES), the vocabulary (VOC), and the hidden figures (HFG) test scores as follows:

$$H/S = \frac{2 \times (T\text{-score of GES})}{(T\text{-score of VOC}) + (T\text{-score of HFG})}$$

As secondary considerations of the study, the presence of any statistically significant aptitude effects on the learning outcomes were checked, as were any treatment main-effects on performance. Last, some of the possible interactions based in the affective domain, as determined by opinion questions, were also statistically evaluated.

RESULTS

No statistically significant aptitude-treatment interactions emerged from the regression analyses performed on the data. Preliminary analysis had yielded some substantial interactions, but further inspection of the data indicated the need to incorporate pretest scores as covariates, which in turn eliminated the observed interactions. Thus, the research hypothesis, or the expectation of the matching conditions (holistic learners and the non-linear instructional treatment as well as serial learners and the linear instructional treatment) yielding better outcomes than the mismatching condition, could not be supported.

Some secondary observations of interest *were* made. Thus, an interaction between instructional strategy and testing mode was observed: those receiving the linear, more verbally-oriented, presentation performed significantly better on the task requiring writing the answers out longhand, than did the group receiving the more visually-oriented presentation. Hence, written responses seem easier to produce following a more verbal instruction. Also, a significant increase in delayed retention test scores, on the task based on multiple-choice answers, was observed compared to performance on the immediate posttest. However, this effect was not significantly related to any treatment differences. Apparently, the frequently mentioned improvement in retention, associated with multi-image presentations, applies equally to learning from all "slide-shows" (no matter in which format) so long as learning is measured by multiple-choice tests. None of this improvement could be related to the respondents' between-tests activities, and hence cannot be ascribed to any acquisition of additional information.

Another interesting observation was the discovery that very few college students could be considered to be "holists" in the sense of the H/S ratio, that is those who score high on the gestalt closure test while simultaneously scoring low on both vocabulary and hidden-figures tests. Indeed, if a score in the top or bottom thirds of each measure were required to assign a participant to the "high" or the "low" classification, then less than 10% of the entire sample of 190 would fall into the combined "holist" *and* "serialist" categories, with 90% falling into a "middle of the road" category. Thus a possible "filtering out process" appears to take place in our educational system which may make the effort to design special "matched" instructional materials a trivial task. This, of course, does not prove that some *other* construct similar to the H/S ratio may not be found to yield more meaningful results, or that more interesting results couldn't be found with different populations.

IMPLICATIONS

It is not possible to identify whether failure to find interactions between treatments and aptitudes can be said to result from a) no such interactions being possible, b) the treatments not having the expected characteristics, or c) the cognitive style measures not measuring the expected "holistic" or "serialistic" learning preference.

Other research has used different measures and some have obtained observable differences with some treatments, but, typically quite different statistical analyses were used. The treatments in this study, in an effort to make them "ecologically valid" as examples of "linear" and "non-linear" presentations, did not maintain most of the variables constant between them. Thus, future studies done in this vein, should consider retaining both the time and narrative constant while only varying the visual aspects. Furthermore, there also exists the opposite possibility of making the two versions even more divergent by modifying the internal conceptual organization of the non-linear version so as to make its logical development non-linear as well.

In addition to the measures used in this study, there exist numerous other appropriate cognitive measures-even of gestalt completion, or holistic processing--which merit further consideration. Both the "Mooney Faces" (Mooney, 1957) as well as other possible face recognition tasks suggest themselves as likely candidates for measuring holistic aptitudes. Similarly, it maybe worth waiting to see what kind of success the new computerized "Spy Ring History Test" recently available from B.C.E. Scott might enjoy (cf. Pask & Scott, 1972) as a novel "holistic" measure.

One of the benefits to be derived from this study may well be the methodology used here for attacking this type of problem. It is felt that it is probably somewhat more cautious in its approach than many others that the author has encountered in the literature and would be well worth considering when developing future aptitude-treatment interaction research designs.

REFERENCES

Allen, W. H., & Cooney, S. M. A study of the non-linearity variable in filmic presentation. Los Angeles: University of Southern California, 1963, NDEA Special Report, Project No. 422.

Bogen, J. E. The other side of the brain, II. An appositional mind. Bulletin of the Los Angeles Neurological Society, 1969, 34,

Bogen, J. E., DeZure, R., TenHouten, W. D., & Marsh, J.F. The other side of the brain, IV. The A/P ratio. Bulletin of the Los Angeles Neurological Society, 1972, 37 49-61.

Brydon, W. P. Comparing single-screen and three-screen presentations. Unpublished doctoral dissertation, University of Southern California, Los Angeles, 1972.

Cronbach, L. J., & Snow, R. E. Aptitudes and instructional methods: A handbook for research on interactions. New York: Irvington (Halsted Press), 1977.

Harshman, R. A., Crawford, H. J., & Hecht, E. Marihuana, cognitive style, and lateralized hemispheric functions. in S. Cohen & R. C. Stillman, The therapeutic potential of marihuana. New York: Plenum Medical Book Company, 1976.

Kerlinger, F. N., & Pedhazur, E. J. Multiple regression in behavioral research, New York: Holt, Rinehart & Winston, 1973.

Mooney, C. M. Age in the development of closure ability in children. Canadian Journal of Psychology, 1957, 11, 219-226.

Nie, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., & Bent, D. H. SPSS: Statistical package for the social sciences. New York: McGraw-Hill, 1975.

Pask, G., & Scott, B. C. E. Learning strategies and individual competence. International Journal of Man-Machine Studies, 1972, 4, 217-253.

Street, R. F. A gestalt completion test--A study of a cross section of intellect. New York: Teachers College, Columbia University, Contributions to Education, No. 481, 1931.

Witkin, H. A., Cox, P. W., Friedman, F., Hrishikesan, A. G., & Siegel, K. N., Supplement No. 1, Field-dependence-independence and psychological differentiation: Bibliography with index (Research Bulletin 74-42). Princeton, N. J.: Educational Testing Service, 1974.

Witkin, H. A., Cox, P. W., & Friedman, F. Supplement No. 2, Field-dependence-independence and psychological differentiation: Bibliography with index (Research Bulletin 76-28). Princeton, N. J.: Educational Testing Service, 1976.

Witkin, H. A., Oltman, P. K., Cox, P. W., Ehrlichman, E., Hamm, R. M., & Ringler, R. W. Field-dependence-independence and psychological differentiation: A bibliography through 1972 with index (Research Bulletin 73-62). Princeton, N. J.: Educational Testing Service, 1973.

TITLE: A Comparison of the Effectiveness of Massed
and Distributed Practice Using Computer
Assisted Adjunct Auto-Instruction as a
Reviewing Method with College Students
of Varying Abilities

AUTHOR: Jo Ann Nelson

A COMPARISON OF THE EFFECTIVENESS OF MASSED AND DISTRIBUTED PRACTICE USING COMPUTER ASSISTED ADJUNCT AUTO-INSTRUCTION AS A REVIEWING METHOD WITH COLLEGE STUDENTS OF VARYING ABILITIES

Jo Ann Nelson, Ph. D.
Educational Studies
California State College
California, Pennsylvania 15419

A research paper presented
at the 1980 Convention of the
Association for Educational Communications and Technology
sponsored by the
Research and Theory Division
April, 1980 in Denver, Colorado

INTRODUCTION

In most conventional classrooms, tests are used almost exclusively for evaluation (Paige, 1966), with a high grade being the only reward for student achievement. Tests are scheduled infrequently, covering correspondingly large blocks of subject matter. Often feedback is long delayed. In addition, observable posttest behavior demonstrates repeatedly that such procedures or traditional testing practices are more likely "to terminate study than to initiate or guide it" (Hammer and Henderson, 1972, p. 25).

Over the last decade, a promising computer assisted instructional strategy for the improvement of instruction has emerged. The most popular version of this innovation is known as Computer Generated, Repeatable Testing (CGRT). This new system of instruction is intended to maintain moderate motivation in students throughout the semester rather than to induce the loaf-and-cram cycle of study and "the apathy-anxiety-hostility-frustration cycle" (Jensen, 1973, p. 28) of emotion and motivation. Computer test generation and scoring provide efficient, low cost, quality procedures for repetitive evaluations of performance using unique but equivalent examination forms (Ansfield, 1973; Cohen and Cohen, 1973; Dudley, 1973; Hammer and Henderson, 1972; Jensen, 1973; Menne, 1973;

Prosser, 1973). However, most attempts at computer test generating have centered on the production of pencil and paper varieties of multiple-choice, true-false, and matching items "which lack the provision for immediate feedback, and consequently for improved learning" (Cartwright and Derevensky, 1975, p. 2).

An alternative method to CGRT has been suggested by Cartwright and Derevensky (1975). They propose allowing the computer to actually administer the test and provide feedback immediately on each test item as it is encountered. Franklin and Marasco (1977) explain this alternative method as "interactive programs which pose to a student, sitting at a terminal, a series of questions" (p. 20) and immediately evaluate the student's response. Hershkowitz and Wojcik (1975) identify other beneficial characteristics:

> Since such testing systems are much simpler, both in structure and implementation, than a programmed learning module, they represent an alternative approach to computer aided instruction, one which is easier for the unsophisticated user to implement and yet does accomplish the goal of assisting subject mastery (p.15).

Perhaps the old saying 'practice is the best of all instructors' is really a truism. The instructional strategy of interspersing practice tests between periods of conventional instruction and formal examinations is attributed to Sidney L. Pressey (1926, 1927, 1950). This practice testing strategy, which is termed both adjunct auto-instruction or the self-scoring test, presents multiple-choice questions, requires an active response, and provides immediate knowledge of results.

Little (1934) and other students and associates of Pressey (Angell and Troyer, 1948; Jensen, 1949; Paige, 1966; Pressey and Kinzer, 1964) have contributed methods of implementing adjunct auto-instruction. Their research in comparing auto-instructional methods with conventional classroom methods still constitute the primary source of evidence that auto-instructional devices offer a reliable method of facilitating learning by supplementing conventional classroom instruction.

While utilizing similar adjunct auto-instructional techniques presented by computer assisted instruction, Gilman (1969) researched the effects of five different types of feedback. The poor results demonstrated by the knowledge of results feedback group in Gilman's study raises questions as to whether this mode of feedback is adequate for an adjunct auto-instructional program. Most of the studies involving adjunct auto-instruction and many types of teaching machines have utilized knowledge of results feedback and have only informed the student whether his response was 'correct' or 'incorrect'.

Comparing the results of his five experimental groups, Gilman (1969) concluded that the learners who received only the 'knowledge of results' feedback did not learn as effectively nor perform as well as those learners who received feedback that guided them to the correct response. Gilman's experimental research findings are in agreement with those of Bryan and Rigney (1956) and Montor (1970). Furthermore, Gilman (1969) reported that there is value in repeating the program items until the learner has answered all items successfully. This procedure provides a 'drill' type of practice in a test situation.

The old maxim 'practice makes perfect' is a combination of truth and error. A great amount of time can be spent on practice with little or no improvement in learning or performance; yet, very few concepts or skills can be developed without some practice. Therefore, is it the practice itself or the conditions of practice which 'make perfect'? To solve this dilemma educators have examined the effects of massed and distributed practice as one condition of learning.

Dececco points out that "most textbooks in the past rather flatly reported that more learning resulted from distributed than from massed practice" (1968, p. 346). However, not many teachers or learners have taken this often repeated statement seriously. This is evidenced by teachers who ignore the necessity for review and by learners who continue to perpetuate the loaf-and-cram cycle of studying for tests. Moreover, when time is taken into account, massed practice takes less time than distributed practice.

How to make the time spent on practice or review productive is therefore an appropriate topic to be considered by all educators, to the end that the practice students engage in will be effective in promoting learning, and economical in terms of the time given to it. Through this study, teacher education majors discovered for themselves the relative effectiveness of massed and distributed practice in reviewing meaningful academic subject matter.

Statement of the Problem

The purpose of this study (Nelson, 1979) was to compare the effectiveness of massed and distributed practice, using computer assisted adjunct auto-instruction, as a method of content review with college students of varying abilities.

Hypotheses

The following hypotheses were tested by statistical analysis of the data collected:

1. There is no significant difference in mean achievement scores for high, average, and low ability students.

2. There is no significant difference in mean achievement for students under the control, distributed, and massed practice conditions.

3. There is no significant interaction between students' ability levels and practice conditions.

METHODOLOGY

Population

The population consisted of the students enrolled in the three sections of the Introduction to Educational Media (EDF-305) taught by this researcher during the Fall 1978 term at California State College, California, Pennsylvania, who were present to take all examinations and who were not repeating the course (N=108).

The group was comprised of 108 students (55 males and 53 females). All were majoring in some field of education. Seventy were juniors, twenty-five were seniors, and thirteen were seeking certification. The ages ranged from 20 to 44 years with the mean age being 22.9.

A personal data inquiry was completed by each student. The data collected from the personal data inquiry are summarized in Table 1 to give an overall description of the individuals participating in the study.

Table 1

Composition of Population by Educational Major and Sex

(N=108)

Area of Concentration	Male	Female	Total	Percent
Industrial Arts Education	31	2	33	30.6
Elementary Education	7	25	32	29.6
Secondary Education	12	6	18	16.7
Special Education	4	13	17	15.7
Early Childhood Education	1	7	8	7.4
Total	55	53	108	

Research Design Employed

Due to the learners' self-selection of the Introduction to Educational Media sections and the known difficulty of conducting an authorized experiment without the learners being aware of it, this researcher assigned the preassembled, intact sections randomly to treatment groups.

Since this researcher proposed to evaluate three levels or variations of the treatment, the research design known as the Counterbalanced Design was selected. This rotation-type design seeks to achieve experimental control by exposing all groups to all levels of treatment by means of the Latin-square arrangement (Campbell and Stanley, 1963).

The counterbalanced research design employed in this study permitted this researcher to rotate the same level of the independent variable (treatment) among different sections at different times throughout the semester-long duration of the experiment with each section receiving equivalent but different units of work (Best, 1970). The independent variable was identified as treatment or type of practice which consisted of three levels: (1) massed practice; (2) distributed practice; (3) traditional practice. The dependent variable was identified as achievement.

As shown in Figure 1, the 3 x 3 Latin-square contained three classifications:

1. Groups of learners (sections)
2. Experimental levels of treatment; $X_{(cntl)}$ = traditional practice, the control condition;
   $X_{(dist)}$ = distributed practice;
   $X_{(mass)}$ = massed practice
3. Times or order of experiment sessions (replications)
   T_1 = first unit of study for a period of four weeks
   T_2 = second unit of study for a period of four weeks
   T_3 = third unit of study for a period of four weeks

Time

Groups		T_1	T_2	T_3
	A	$X_{(cntl)}$	$X_{(dist)}$	$X_{(mass)}$
	B	$X_{(dist)}$	$X_{(mass)}$	$X_{(cntl)}$
	C	$X_{(mass)}$	$X_{(cntl)}$	$X_{(dist)}$

Figure 1. The 3 x 3 Latin-square containing 3 classifications in the study.

As shown in Figure 1, there were three variations of the treatment applied to three different groups in such a way that: (a) a different treatment was presented to each group each time, and (b) each treatment preceded and followed each other treatment an equal number of times.

After all the experimental sessions were completed, this researcher turned the Latin-square so that the treatments became column heads (see Figure 2). Then the scores were recorded in each cell and the column mean was computed. A column mean represented the average score for all groups when exposed to the particular treatment in the column heading. A comparison of these mean scores revealed what effect the different levels of the independent variable had upon the group performance.

Treatment Variations

Groups	$X_{(cntl)}$	$X_{(dist)}$	$X_{(mass)}$
A	T_1	T_2	T_3
B	T_3	T_1	T_2
C	T_2	T_3	T_1

Figure 2. The 3 x 3 Latin-square containing replications in the study.

LEARNING MATERIALS

The textbook used in the course was *AV Instruction: Technology, Media, and Methods*, 5th edition, by Brown, Lewis and Harcleroad (1977). Permission to prepare the computer assisted instructional modules was granted by the senior author of the textbook, Dr. James W. Brown (1978).

Three different criterion tests were used to investigate the extent to which achievement scores were dependent upon treatment level received. Each consisted of twenty-five true-false, fifty multiple-choice, and twenty-five matching items. Based upon the questions suggested in the manual which accompanies the textbook, this researcher constructed the tests. All learners recorded their responses on optical scanning forms. Having been used the previous semester, Spring term of 1978, a summary of results of this test validation is presented in Table 2.

Table 2

Results of Validation of Criterion Tests

(Spring 1978)

	Unit 1	Unit 2	Unit 3
Number of persons	94	94	94
Mean Score	73.99	68.94	73.62
Median Score	75.64	68.50	74.17
Standard Deviation	9.08	10.39	9.14
Reliability Estimate (KR-20)	0.82	0.85	0.83

In addition to the three criterion tests, the Otis Quick Scoring Mental Ability Test (Form FM) and the Nelson-Denny Reading Test (Form A) were administered in order to investigate the generalized estimate of mental ability and reading ability of each learner. Each learner's cumulative quality point average was also obtained. Only to satisfy this researcher's curiosity, a short form questionnaire was administered to determine students' reactions towards computer assisted adjunct auto-instruction and practice schedules.

The learning materials for the experimental conditions consisted of computer assisted adjunct auto-instructional programs designed and programmed in the language BASIC by this researcher. Computer assisted adjunct auto-instruction was defined as an instructional strategy of interspersing interactive practice tests in a drill and practice situation to a number of students simultaneously. A tutorial atmosphere was achieved through immediate, personalized knowledge of results and explanatory feedback (Nelson, 1979).

It was emphasized that the computer assisted adjunct auto-instructional programs were not meant for the instructor's evaluation purposes but as aids to the learners' learning and their achievement on the criterion tests. Therefore, the learners were permitted to use their textbooks and any notes they had during the computer review.

All of these adjunct auto-instructional programs were programmed in BASIC on a Sperry Univac Virtual Memory Operating System/9 (VMOS/9) computing system. No knowledge of programming or computer experience was required of any learner.

EXPERIMENTAL TREATMENTS

Both the distributed and the massed practice conditions interactively administered multiple-choice test questions in a randomized order to a student by means of an ASR-33 teletype terminal operating at 110 baud. The student typed in his response and was immediately informed if the response was correct or incorrect. In addition, if correct, the learner received a feedback statement of why the response was correct. This statement served to amplify his response. However, if incorrect, he received a feedback statement of why the response was incorrect and to which page in his textbook he should refer. This statement served to clarify his response. Having completed this practice test, he received a personalized progress report. Then all questions he missed were reiterated. This process of reiteration continued until the pre-determined criterion level was reached; i. e., all questions were answered correctly. Throughout the entire computerized quiz, the learner was addressed personally, just as a tutor would do.

In the distributed practice condition, $X_{(dist)}$, each of the four major topics of the unit was reviewed at the computer within a week after it was presented by means of conventional classroom instruction. That topic was not discussed again. The distributed practice condition consisted of four separate practice tests; each test consisted of ten questions taken from one chapter of the textbook and required approximately twenty minutes to accomplish.

In the massed practice condition, $X_{(mass)}$, the entire unit of instruction was presented by means of conventional classroom instruction; then it was all reviewed at one time on the computer terminal. The massed practice condition consisted of one practice test comprised of forty questions taken from four chapters in the textbook and randomly presented. The questions were the same questions asked during the distributed practice schedule; however, during the massed practice treatment the students spent approximately eighty minutes at the computer terminal during the week of the scheduled criterion test.

In the control practice condition, $X_{(cntl)}$, students, having received the conventional classroom instruction, reviewed for the criterion test in the traditional manner, i. e., without any computer assistance.

SECURITY

This researcher concedes that absolute, tight security was impossible. Nevertheless, the learners who were not in the designated experimental treatment at the designated time were prevented access to the computer. This was controlled by the computer user-identification numbers' file. Each authorized learner $X_{(dist)}$ logged on the system under this researcher's user-identification and account number. He then identified himself with his own passcode. This passcode consisted of the first three letters of his last name and the last four numerals of his Social Security number. By requiring such a double combination, security was maximized. In addition, when the learner in this distributed practice experimental treatment group reached the criterion level; i.e., all ten questions answered correctly, he was denied access to that same program again.

The authorized learners $X_{(mass)}$ logged on the system under this researcher's user-identification and account number, one different from that which the distributed group used. The learners in group $X_{(mass)}$ also, identified themselves with their personalized passcode. Having reached the criterion level, all forty questions answered correctly, they were not permitted to return to that program again. This was accomplished by instructions embedded within the computer program itself.

To prevent the paper copies from circulating on campus among learners, each learner upon completion of each program rolled his paper copy into a small cylinder, secured it with a rubber band and deposited it in the window box of the computer operator's room. Each day this researcher collected all paper copies submitted. Each learner was under the impression that his submitted paper copy was his only evidence that he had completed the assignment; however, this researcher had embedded instructions within the computer program which generated computer files containing all pertinent information concerning each learner's performance.

COLLECTION OF THE DATA

The results of the Otis Quick-Scoring Mental Ability Test (Form FM) revealed that the generalized estimate of the subjects' mental ability or intelligence quotient ranged from 130 IQ to 88 IQ with a mean IQ of 109 and a standard deviation of 9.27.

The Nelson-Denny Reading Test (Form A) results revealed that the subjects' reading vocabulary and comprehension ranged from raw scores of 135 to 35 with the mean raw score being 76.60 and the standard deviation 21.74. Using the grade equivalent norm table which accompanies the test manual, the grade equivalents were 14.0 (the table doesn't go beyond the 14.0 level) to 8.4 with the mean grade equivalent being 13.2.

The quality point or grade average of each subject was obtained from his/her transcript by means of computer retrieval. The highest quality point average was 4.00; the lowest quality point average was 2.00. The mean was 3.02 and the standard deviation was 0.56.

Presented in Table 3, is a summary of the results reported.

Table 3

Summary of the Mean Raw Scores and Standard Deviations of the Ability Variables

(N=108)

Ability Variables	Mean Raw Score	Standard Deviation
Otis Mental Ability Test (Form FM)	50.62*	9.27
Nelson-Denny Reading Test (Form A)	76.60**	21.74
Quality Point Average	3.02	0.56

* Interpreted as 109 intelligence quotient
** Interpreted as 13.2 grade equivalent

Table 4 presents the mean and standard deviations of the three different unit criterion tests which were used to investigate the extent to which achievement scores were dependent upon the level of treatment.

Notice that for each unit of study the massed practice level of treatment achieved slightly higher mean scores than the distributed practice level of treatment. Also, notice that in only one unit (Unit 3) the control condition achieved slightly higher mean scores than the distributed practice level of treatment. The latter might be attributed to the control group's desire to 'beat the system'. Many students boastfully admitted that they were "consciously reading and studying these last four chapters to be able to keep up with the students that will be using the computer." Perhaps having experienced both the distributed and massed conditions and then being deprived access to the computer served as a great motivating factor.

Table 4

Summary of Mean and Standard Deviations for the Three Unit Criterion Tests for Each Group and Each Level of Treatment

	Unit 1	Unit 2	Unit 3
	Control	Distributed	Massed
Group A	75.81*	71.49	76.16
(N=37)	(7.55)**	(9.17)	(9.58)
	Distributed	Massed	Control
Group B	77.70	71.81	74.11
(N=37)	(7.72)	(9.22)	(9.01)
	Massed	Control	Distributed
Group C	77.77	67.12	73.97
(N=34)	(9.40)	(10.78)	(11.20)
Total	77.07	70.22	74.77
(N=108)	(8.21)	(9.86)	(9.89)

* Group mean
** Standard deviation

DATA ANALYSIS

For the purpose of testing all three null hypotheses, it was necessary to divide subjects into groups representing high, average, and low academic abilities. Therefore, the following procedure was used for this purpose. Subjects' generalized estimates of mental ability, reading scores, and cumulative quality point averages underwent a Normalized Transformation to produce scores with a mean of fifty and a standard deviation of ten. The mean of these normalized scores was obtained for each subject and was considered as a comprehensive index of the student's ability.

Using these ability scores, the total population of the study was divided into three ability groups. Low ability level students were defined as those students who scored one-half standard deviation, or less, below the mean. High ability level students were defined as those students who scored one-half standard deviation, or more, above the mean. Average ability level students were defined as those students whose score fell between the two cut off points.

The total means and standard deviations presented in Table 5 represents the average score for all groups when exposed to the particular treatment in the column heading. A comparison of these mean scores reveals that the control treatment level resulted in the lowest achievement score; massed practice level of treatment resulted in the highest

Table 5

Means and Standard Deviations for Achievement in High, Average, and Low Ability Groupings

Ability	N	Treatment						Total
		Control		Distributed		Massed		
		M	S.D.	M	S.D.	M	S.D.	
High	29	82.14	5.19	83.03	5.78	84.69	5.46	83.29
Average	46	72.07	7.39	74.46	7.51	74.09	7.73	73.54
Low	33	64.61	8.53	66.73	8.77	68.33	8.31	66.56
Total	108	72.94	9.81	74.74	9.69	75.70	9.65	

achievement score. However, upon closer examination, it is interesting to note that both the high and the low ability level groups achieved their highest mean scores when exposed to the massed practice level of treatment. However, the average ability group did slightly better when they received the distributed practice level of treatment.

Two way analysis of variance with repeated measures was conducted on the data for the purpose of testing one (ability), two (treatment), and three (interaction between ability and level of treatment). The two way analysis of variance with repeated measures is presented in the summary table below.

Table 7

Two Way Analysis of Variance Summary

Table for Achievement

Source	df	MS	F
Ability	2	6510.14	74.73*
Error	105	87.12	
Treatment	2	205.18	5.35*
Ability X Treatment	4	17.00	0.44
Error	210	38.37	

* Significant at the $p < .01$ level

The results of the two way analysis of variance with repeated measures to test the main effect of ability disclosed that there was a significant difference (F=74.73, df=2/105, $p < .01$). Also, the main effect of treatment level disclosed that there was a significant difference (F=5.35, df=2/210, $p < .01$). The interaction between ability and treatment yielded a nonsignificant F of 0.44.

Because of the unequal numbers among groups and the two way analysis of variance demonstrating a significant difference at the .01 level, the more conservative *Scheffé Test for Multiple Comparisons* was used to isolate the comparisons between the mean. It was found that there was a statistically significant difference at the $p < .01$ level among all ability groups: low and average, average and high, and high and low. For the main effect of treatment level, the massed practice's total mean score exceeded both the distributed practice's and the traditional practice's mean score; however, it was statistically significant at the $p < .01$ level only when compared to the traditional practice, the control condition.

Therefore, the first null hypothesis stating that there is no significant difference in mean achievement scores for high, average, and low achieving students was rejected. The second null hypothesis stating that there is no significant difference in mean achievement for students under the control, distributed, and massed practice conditions was rejected. The third null hypothesis stating that there is no significant interaction between ability grouping and condition was not rejected.

Therefore, it was found that achievement under the three conditions of practice was different with college students of varying abilities. High ability students' scores were always higher than average and low ability students' scores, no matter which treatment they received. The same relationship existed between the two other ability groups' scores, also.

It was also found that college students do achieve differently when they review for a test in the traditional manner, under a condition using computer assisted adjunct auto-instruction with distributed practice, and using computer assisted adjunct auto-instruction with massed practice. The least effective method of reviewing was found to be the traditional manner or the control condition. The most effective method of reviewing was found to be using computer assisted adjunct auto-instruction with the massed practice schedule.

In addition, there was found to be no interaction between the students' ability levels and the level of treatment received.

Positive student attitudes were revealed by means of a five item multiple-choice questionnaire. The students reported that they would have received less out of the course, if the computer had not been used in the course (83.3%). With the same amount of time and effort, the majority of students reported that they either learned somewhat more (62.0%) or much more (19.4%) when studying their textbook with the help of the computer rather in in their usual way. They also admitted that if they were to take another course in a similar field, they would prefer to have computer assisted adjunct auto-instruction used for part of the course (74.1%). The subjects overwhelmingly felt that in being taught by the computer that the instructor was trying to teach them as much as possible with a given expenditure of time and effort (88.0%). When asked which practice schedule they preferred, they chose distributed practice (81.5%) over massed practice (14.8%) and no practice (3.7%).

It is very interesting to note that although students preferred distributed practice, the most effective level of treatment was found to be massed practice. However, it was statistically significant at the $\underline{p} < .01$ level only when compared to the control condition; i. e., traditional review/study methods. Notice, also, that in each comparison of ability level with treatment level as presented in Table 5, distributed practice's total mean score exceeded the traditional practice's total mean score; however, there was no statistically significant difference. Furthermore, considering that the average ability level students did slightly better when exposed to the distributed practice schedule (M=74.46) than when exposed to the massed practice schedule (M=74.09), and considering that one of the criteria which relates to the 'effectiveness' of instruction is the students' opinion of the instruction, perhaps this researcher could suggest that distributed practice is also an effective practice schedule for computer assisted adjunct auto-instruction. Unfortunately, this present study did not allow for any delayed retention measurement of learning.

REVIEW OF THE FINDINGS

The findings of this study (Nelson, 1979) were as follows:

1. There was a statistically significant difference at the .01 level among all ability groups, regardless of the experimental level of treatment received.

2. For the main effect of treatment level, the massed practice's total mean score exceeded both the distributed practice's and the traditional practice's mean score; however, it was statistically significant at the .01 level only when compared to the control condition; i. e., traditional review/study methods.

3. There was found to be no significant difference in the interaction between ability and treatment.

4. Students overwhelmingly preferred distributed practice (81.5%) over massed practice (14.8%). There were

four students (3.7%) who preferred having no practice.

5. There are indications that teacher education majors' attitudes toward computer assisted adjunct auto-instruction were favorable as a result of their participation in this study.

CONCLUSIONS

Often the results or the generalizability of the results of experimental research studies related to the efficacy of distributed and massed practice conditions have been questionable, in terms of verbal learning (Fishman, Keller and Atkinson, 1968; Ingle, Remstad, Gephart, and Lampsa, 1969; Oseas and Underwood, 1952; Reed, 1924; Underwood, 1961; Welborn and English, 1934). Solving mazes, memorizing nonsense syllables, poems or prose passages, and even spelling words correctly involve learning tasks which do not correspond with the 'real world' skills needed by a college student struggling with the subject matter content in order to pass a required course. In addition, many studies have been conducted with only one week or less exposure to the instructional materials or treatment.

To overcome these limitations, an attempt was made by this researcher to enhance the external validity of this study by maximizing the similarity between the conditions in which the behavior was studied and those conditions to which the results of the study can be generalized. To accomplish this, the study was structured around the kind of subject matter that is typically encountered by college students. In addition, the counterbalanced research design employed in this study sought to achieve experimental control by exposing all three sections of Introduction to Educational Media taught by this researcher to all treatments on a rotation basis ranging over a period of one semester; i. e., fifteen weeks. Therefore, it is the hope of this researcher that this study will offer a more significant implication to everyday educational application.

The implications of this study for the classroom teacher are not astounding. However, this researcher has contributed another method of implementing Sidney L. Pressey's (1926, 1927, 1950) adjunct auto-instructional strategy of interspersing practice tests between periods of conventional instruction and formal examinations. Although Little (1934) and other students and associates of Pressey (Angell and Troyer, 1948; Jensen, 1949; Paige, 1966; Pressey and Kinzer, 1964) contributed methods of implementing adjunct auto-instruction, this present investigation was unique in the fact that it employed the use of a computer system which provided the student with immediate, personalized, explanatory feedback. Therefore, this study provides fresh evidence that auto-instructional devices which support specific learning objectives still offer a reliable method of facilitating learning by supplementing conventional classroom instruction.

> Teacher training institutions have a challenge to anticipate the changing role of the teacher rather than follow at the heels of classroom practice (Hansen and Harvey, 1970, p. 48).

Computers are already being utilized in a variety of administrative and instructional programs in elementary and secondary schools throughout the United States. When one concedes the inevitability of the use of the computer to support educational processes, the implications for teacher education need examination. Ellison (1970) contends that this is particularly true if we expect teachers of today and tomorrow to be able to utilize this new tool with confidence and purpose, without fear of either the 'technological monster' or of their security. Needless to say, when an educator has an inadequate understanding of the potential and limitations of computers in an educational environment and the computer becomes available to his school, the computer is often misused (Oettinger, 1969). In addition, the computer's unique educational potential is "not optimized by teachers who are locked into teaching styles by lack of perception, experience, and training" (Lunetta, 1975, p. 293).

The old axiom 'teachers teach as they are taught and not as they are taught to teach' is recognized by this researcher and others as a mixture of truth and error. However, it does place emphasis on the major objective of the teacher education curriculum. Consequently, it seems reasonable to project that if we are to produce such a new generation of technologically oriented teachers, the computer must be intimately related to their own lives and their own education (Ellison).

Therefore, by actually obtaining some of their own professional education through the medium of the computer, future teachers, the subjects in this study, were provided with a perception of computer capabilities and limitations, as well as an exposure to another teaching style which will hopefully enable them to maximize all the resources available to support instruction.

RECOMMENDATIONS

On the basis of the findings of this investigation, the following recommendations for further research and study are :

1. Since this study did not measure delayed retention, a follow up study should be conducted to include achievement measurements after a period of time has elapsed.

2. In view of the contradictory results concerning massed practice's proven effectiveness but distributed practice's proven preference, additional conditions should be studied. These conditions might include the utilization

of faster teletype terminals and/or video screen terminals. In this way, the fatique factor and the frustration level may be decreased somewhat.

Angell, G. W., & Troyer, M. E. A new self-scoring test device for improving instruction. School and Society, 1948, 67, 84-85.

Ansfield, P. J. A user oriented computing procedure for compiling and generating examinations. Educational Technology, 1973, 13, 12-13.

Best, J. W. Research in education (2nd ed.). Englewood Cliffs, New Jersey: Prentice-Hall, 1970.

Brown, J. I., Nelson, M. J., & Denny, E. C. Examiner's Manual: The Nelson-Denny reading test: vocabulary, comprehension, rate. Boston: Houghton Mifflin, 1973.

Brown, J. W. Personal communication, February 1, 1978.

Brown, J. W., Lewis, R. B., & Harcleroad, F. F. AV instruction: technology, media, and methods (5th ed.) New York: McGraw-Hill, 1977.

Bryan, G. L., & Rigney, J. W. An evaluation of a method for shipboard training in operations knowledge. (Tech. Rep. 18). Los Angeles: University of Southern California, Electronics Personnel Research Group, Department of Psychology, September 1956.

Campbell, D. T., & Stanley, J. C. Experimental and quasi-experimental designs for research on teaching. In N. L. Gage (Ed.). Handbook of research on teaching. Chicago: Rand McNally, 1963.

Cartwright, G. F., & Derevensky, L. L. An attitudinal study of computer-assisted testing as a learning method. Washington, D. C.: National Citizens Conference on Rehabilitation of the Disabled and Disadvantaged, April 1975. (ERIC Document Reproduction Service No. ED 107 721)

Cohen, P. S., & Cohen, L. R. Computer generated tests for a student paced course. Educational Technology, 1973, 13, 18-19.

DeCecco, J. P. The psychology of learning and instruction: educational psychology. Englewood Cliffs, New Jersey: Prentice-Hall, 1968.

Dudley, T. J. How the computer assists in pacing and testing students' progress. Educational Technology, 1973, 13, 21-22.

Ellison, A. Problems of applying computer technology to teacher education. *Educational Technology*, 1970, *10*, 35-39.

Fishman, E. J., Keller, L., & Atkinson, R. C. Massed versus distributed practice in computerized spelling drills. *Journal of Educational Psychology*, 1968, *59*, 290-296.

Franklin, S., & Marasco, J. Interactive computer-based testing. *Journal of College Science Teachers*, 1977, *7*, 15-20.

Gilman, D. A. The effect of feedback on learners' certainty of response and attitude toward instruction in a computer assisted instruction program for teaching science concepts. *Journal of Research in Science Teaching*, 1969, *6*, 171-184.

Hammer, M., & Henderson, E. O. Beat the 'loaf-cram' cycle with computer tests. *College Management*, 1972, *7*, 25-27.

Hansen, D. N., & Harvey, W. L. Impact of CAI on classroom teachers. *Educational Technology*, 1970, *10*, 46-48.

Hershkowitz, S. J., & Wojcik, R. J. Interactive testing-evaluation in an introductory computer science course. *Journal of Educational Data Processing*, 1975, *12*, 15-22.

Ingle, R. B., Remstad, R. C., Gephart, W. J., & Lampsa, L. V. Massed versus spaced practice: a classroom investigation. *Educational Leadership*, 1969, *3*, 261-264.

Jensen, B. T. An independent-study laboratory using self-scoring tests. *Journal of Educational Research*, 1949, *43*, 134-137.

Jensen, D. D. Toward efficient, effective and humane instruction in large classes: student scheduled involvement in films, discussions and computer generated repeatable tests. *Educational Technology*, 1973, *13*, 28-29.

Little, J. K. Results of use of machines for testing and for drill upon learning in educational psychology. *Journal of Experimental Education*, 1934, *3*, 45-49.

Lunetta, V. N. Computer in the classroom: unit in teacher education. *Journal of Educational Technology Systems*, 1975, *3*, 293-302.

Menne, J. W. Computer assisted test assembly at Iowa State University. *Educational Technology*, 1973, *13*, 31-32.

Montor, K. Affect of using a self-scoring answer sheet on knowledge retention. *The Journal of Educational Research*, 1970, *63*, 435-437.

Nelson, J. A. *A comparison of the effectiveness of massed and distributed practice using computer assisted adjunct auto-instruction as a reviewing method with college students of varying abilities*. Unpublished doctoral dissertation, University of Pittsburgh, 1979.

Oettinger, A. G. *Run, computer, run; the mythology of educational innovation*. Cambridge, Massachusetts: Harvard University Press, 1969.

Oseas, L., & Underwood, B. J. Studies of distributed practice: V. learning and retention of concepts. *Journal of Experimental Psychology*, 1952, *43*, 143-148.

Paige, D. D. Learning while testing. *Journal of Educational Research*, 1966, *59*, 276-277.

Pressey, S. L. A simple apparatus which gives tests and scores-and teaches. *School and Society*, 1926, *23*, 373-376.

Pressey, S. L. A machine for automatic teaching of drill material. *School and Society*, 1927, *25*, 549-552.

Pressey, S. L. Development and appraisal of devices providing immediate automatic scoring of objective tests and concomitant self-instruction. *Journal of Psychology*, 1950, *29*, 417-449.

Pressey, S. L., & Kinzer, J. R. The effectiveness of adjunct auto-instruction. Tucson, Arrizona: Arizona University, 1964. (ERIC Document Reproduction Service No. ED 003 336)

Prosser, F. Repeatable tests. *Educational Technology*, 1973, *13*, 34-35.

Reed, H. B. Distributed practice in addition. *Journal of Educational Psychology*, 1924, *15*, 248-249.

Underwood, B. J. Ten years of massed practice on distributed practice. *Psychological Review*, 1961, *68*, 229-247.

Welborn, E. L., & English, H. B. Logical learning and retention: a general review of experiments with meaningful verbal materials. *Psychological Bulletin*, 1937, *39*, 1-20.

TITLE: Assessment and the Control Function in
Systems of Continuing Education

AUTHOR: Thomas G. Nielsen

ASSESSMENT AND THE CONTROL FUNCTION[1] IN SYSTEMS OF CONTINUING EDUCATION

Thomas G. Nielsen, Ed.D.
Southeastern Regional Medical Education Center
Veterans Administration
Birmingham, Alabama

Within and beyond the field of educational technology there has been a growing interest in and concern for the identification, analysis and evaluation of "needs" in the systematic process of instructional development. While an increasing number in our field seem to have recognized and become concerned with needs assessment, few, if any, appear interested in establishing needs assessment within a theoretical framework that may give us a better understanding of its nature and function in the systems to which it is applied.

A better understanding is particularly important in continuing education, for it is in this domain that needs assessment most directly interfaces the educational process and the world of expectation, performance and accountability.

Control theory, as it is being developed and applied in the study of living systems, provides a useful theoretical framework for considering, among other things of interest to us, the nature and function of needs assessment in continuing education.

What I am proposing is to present and examine a model of a feedback control system derived from and applied to living systems and to extend its application to continuing education, with a focus on assessment.

---

1. A paper presented for the Research and Theory Division, Association for Educational Communications and Technology, Denver, Colorado, April 24, 1980.

The views expressed in this paper are those of the author and do not necessarily reflect policies of the Veterans Administration.

The concept of feedback is familiar to us all. In the simplest modification of the S-R paradigm we find the introduction of the concept of feedback. In learning theory it appears in numerous models, under the guise of Effect, as in the S-O-R-E paradigm (Stimulus-Organism-Response-Effect) or as KOR (Knowledge of Results). In instructional development we find the ubiquitous feedback loop, feeding back information to earlier stages in our ID models and activities.

One of the more interesting and more directly related applications of feedback is found in Miller, Galanter and Pribram's (1960) TOTE unit (See Figure 1), in which the results of an operation phase are fed back as information to a test phase in their model of the structure of behavior. Here we see the first signs of functional assessment (Test) in a behavioral process model.

Missing, however, from the symbolic representation (but not the theory) of the TOTE unit, are two significant components, one of which is of fundamental concern to assessment. Miller, Galanter and Pribram refer to them as Images and Plans. Plans provide the hierarchical control of operations, while Images provide the guidance and direction, the evaluative criteria for the tests.

Since the introduction of the TOTE, Images and Plans in 1960, these constructs have seen a variety of applications, particularly in the fields of neuropsychology and neurophysiology. Pribram (1971) has since modified the TOTE to incorporate feed-forward, a counterpart to feedback which biases, i.e., predisposes, operations in the TOTE.

William T. Powers (1972) has extended the concept of feedback control and, in so doing, has formulated a powerful and provocative theory of living systems behavior. The major premise of his theory is that the behavior of living systems functions by means of feedback control organizations to control perceptions. That is to say, what we do is done to control what we perceive. You and I have walked across the room to adjust the picture hanging crooked on the wall. We have behaved to control what we have seen.

A simplified model of a feedback control organization consists of a number of system functions and signals interfacing with some phenomena in the physical world (See Figure 2). Such an organization is part of a hierarchical structure of similar organizations (an idea which I shall shortly attempt to explain). The input function serves to detect the value of some quantity, condition or state of affairs which may be changing as a consequence of an external "disturbance". The input function generates or "computes" a perceptual signal that varies as a function of the detected, controlled quantity. A reference signal, originating elsewhere in the hierarchy of feedback control organizations, represents a goal, value or standard to which the perceptual signal is referenced in the comparator function. An error signal results from the "algebraic summing" of an inverted perceptual signal and the reference signal. So, when the perceptual and reference signals are equal, the error signal is zero. The output function is "driven" by the error signal, operating on the controlled quantity to counter the disturbance and, thereby, changing the perceptual signal. A proper operation will result in bringing the value of the perceptual signal closer to that of the reference signal and, consequently, will reduce the magnitude of the error signal.

As Powers has noted, the reference signal is the most important explanatory feature of the control system unit of behavioral organization. In Miller, Galanter and Pribram's terms, its source is an Image, the reference condition.

A second premise of Power's theory is that there exists in any living system a hierarchy of feedback control organizations such that perceptual signals from lower levels are fed, upward, to higher levels and, conversely, reference signals from higher levels are fed, downward, to lower levels in the hierarchy. That is to say, higher levels of control receive feedback, directly, from lower levels of control as well as providing reference signals to lower levels. Add to this the capability of feeding forward bias signals to input and output functions, predisposing them to detect or operate in certain ways, and you have a complete, if simplified, theoretical model of feedback control in living systems.

Powers has applied the hierarchical principle of perceptual control to human neurological functioning and proposes at least nine levels. Beginning at the lowest level of perceptual control we find perceptions of intensity, sensation, configuration, transition, sequence or event, relationship, program, principles and system concepts. Each in the hierarchy is a function of the integration and differentiation of lower-order perceptions. The lower levels of the hierarchy are well-illustrated by studies in neuro-physiological and behavioral research; the highest levels are least-well investigated or supported, empirically. Although the latter are tentative and speculative, they are logically consistent with the overall theory as well as consistent with current theories of intelligence, information processing and cognitive functioning.

An example from the behavioral laboratory may be in order to illustrate the abstract model.

I am certain you have all seem the video games in department stores or in your homes or the electronic games in shopping center arcades. Imagine a similar arrangement in a laboratory setting: a video screen, a control stick, a moving target and a spot of light to track the target on the screen. Instructions appear on the screen:

> You will accumulate 10 points for every second the spot is within one (spot) diameter of the target. The control stick in front of you will cause the spot to move left, right, up or down. Begin tracking the target.

The target begins to move about on the screen and you manipulate the control stick in an attempt to obtain and maintain the actual, physical relationship between spot and target (i.e., within one spot diameter).

Powers has illustrated the feedback relationships in such a tracking experiment (See Figure 5.1), showing two levels of perceptual control. In a more complex illustration (See Figure 6.1), he analyses a three-level control system in this tracking situation. In a physiological example (See Figure 7.1) he diagrams the tendon reflex loop, showing a first-order control system for the perception of intensity.

The systems in which we work--the educational institutions, industrial and commercial organizations, government agencies and other bureaucracies--are, despite the pejoratives and protestations of some, living systems.

These living systems are purposeful, goal-oriented, adaptive and hierarchically organized and functioning entities ("organisms") to which control system theory can be usefully applied.

In the contexts of continuing education, instructional development and needs assessment, we can apply control system theory in our analyses and our activities to better understand and serve their goals and purposes.

Part of the application is simple, if not obvious. A "need", often defined as the difference between "what is" and "what should be" can be identified as the error signal in the control system model; "what is" and "what should be" can be related, respectively, to the perceptual and reference signals. Assessment, then, resides primarily in the comparator function. But does it? And is that all there is to it? Not quite.

What the theory and model offer is a way of interrelating these components, among others, in a conceptual framework that leads us to consider some of the characteristics of control systems and to ask some questions not asked before. If the theory and model have utility, new insights should develop and new answers should enlighten us and make us more effective in needs assessment.

A number of feedback control prinicples and concepts as they apply to living systems are relevant to needs assessment, especially in the context of continuing education.

First among them is the hierarchial structure of control in a living system.

Control systems, and the assessment functions which are a part of them, are ordered and interrelated in such a way that a control system at one level receives references from higher order systems of control and, in turn, controls perceptions at its own level by adjusting references to lower order systems of control (See Figure 2). Since assessment functions at all levels, measures can be taken which will incorporate input from all levels. For example, in continuing education, there is assessment at the level of the provider, the level of the employer, and the level of the practitioner, to name just a few. Effective assessment in continuing education will tap all significant sources of input for effective control of the quality and impact of continuing education activities and interventions.

A second principle is that each level of control is concerned with a different class of perceptions. What those perceptions are, how they differ, how they are "integrated" and "differentiated" as one proceeds up the hierarchy is relevant to the understanding of the living system. In continuing education, it is important that we understand the differences in levels of perception and are able to integrate and differentiate them at the appropriate levels of control of continuing education.

A third principle, which is a basic premise of this theoretical model of control, is that all control, and therefore all assessment, is dependent on perception. Within this theoretical framework, there is no distinction between "perceived needs" and "actual needs", for every need (i.e., error) is derived from a comparison of a reference condition and a perceived condition. Perceptions are a function of input processes which may be biased by control systems to selectively sense controlled quantities.

A fourth principle concerns the range of control of a system, which is determined by the maximum possible output and the maximum error tolerated by a normally functioning control system. Frequently, continuing education is called upon to provide results which are outside its range of control. Only when the range of control of a system is understood, can assessment be effectively designed and incorporated into the control system of continuing education.
The concept of feed-forward or biasing of functions is particularly significant in living systems control theory. In one sense, reference conditions bias the functioning of lower order systems of control by affecting them in such a way so as to achieve a pre-selected perceptual result. In another sense input and output functions may be biased to detect or operate in a pre-selected fashion. Recognition of the feed-forward or biasing mechanisms, especially as they operate on input functions, is crucial for an understanding and adjustment of assessment function and control.

As I suggested earlier, in continuing education assessment plays a significant role by interfacing the educational process--including instructional development--on the one hand, and expectations, competence, performance and accountability in the system, on the other. This is particularly evident where professional societies, licensing authorities, government agencies, businesses and individuals are looking more and more toward continuing education as the means of developing, maintaining, and assuring professional competency, performance of new and changing services, and increasing quality, efficiency and accountability in the delivery of services.

Let us take, for example, two views of continuing education. In the first we have provider-centered assessment and control of continuing education (See Figure 3). Here the provider's goals, values and objectives become the references against which sensed conditions are compared. External references, such as enacted legislation, accreditation standards, information on emerging technologies and budgetary factors may contribute to the formulation and prioritization of the internal references. Competence, ideally, is the focal quantity in the real world which continuing education activities and interventions control.

However, the controlled quantities of most direct concern to higher and lower levels in the system (e.g., quality of services or system efficiency) are effected indirectly and are rarely sensed and assessed by the continuing education provider.

In the second view we see learner-centered assessment and control of continuing education (See Figure 4). Here it is the learner's goals, values and objectives which become the reference against which sensed conditions are compared. External references again may contribute to the formulation or prioritization of these internal references. However, at this level of assessment and control, there is a more immediate and direct sensing and control of the focal quantity. At this level, both continuing education interventions (to improve competence) and performance interventions (to affect the controlled quantity) are within the control loop.

Here, at the level of learner-centered control, assessment is an integral part of individual performance, as well as an integral part of the management of performance. I believe it is at this point that continuing education through assessment interfaces with the real world, directly. To have a conscious awareness at this level of the significant quantities being controlled in performance is to have a valuable source of valid perceptions for and resource in needs assessment for continuing education.

Models representing other views of continuing education might be considered in which the locus of control is found elsewhere in the hierarchical structure of the system. I have selected these two for they represent two common and important loci of assessment and control in continuing medical education, today.

The utility of the theoretical framework offered by this control function model of assessment will come from the questions it raises, the answers it provides, and the improvements it enables. Among the more important and interesting questions may be the following:

1. What are the significant levels of perception and control in our systems?
2. What are the significant controlled quanitities?
3. What biases our input functions, directing our attention or enabling us to sense (or ignore) conditions?
4. How do we bias the input functions to detect the controlled quantities more effectively?
5. What are the sources of our reference signals and what effect do they have on our systems?
6. How does continuing education become more responsive to (sensitive to and effective in dealing with) real problems?
7. How are lower levels of control tapped to provide higher levels of control with more direct perceptions of controlled quantities?

8. What is the range of control of our educational interventions?
9. How much error will our systems tolerate?

The answers will have to await consideration and investigation of these and many other questions generated by this conceptual model.

In summary, assessment is viewed as an integral part of the control function in living systems, among which is continuing education. Needs are a function of the comparison of perceptual and reference signals, being equivalent to the error signal in models of feedback control. The behavior of any living system is considered to be motivated by control functions in order to maintain perceptions of controlled quantities at referenced levels. The hierarchical organization of control functions results in the output of higher levels of control functioning as reference signals for lower levels in the system. Feedback, in the conventional sense, is in the perceptual segment of the closed loop. Feedforward is introduced as the means by which functions are biased or pre-disposed to behave (perceive or operate) in pre-determined ways. Differences in "locus of control" result in different perceptions and foci of control. Continuing education, for example, may involve control at the level of the provider or the level of the learner. At the former level, competence is the focal controlled quantity; at the latter level, performance is. Other levels of control are, of course, likely and manifest. The utility of the control functions model of assessment provides a living systems point of view, allowing us to pose new and different questions and, hopefully, enabling us to develop new approaches to studying and applying needs assessment methodology.

REFERENCES

Miller, G. A., Galanter, E., and Pribram, K. Plans and the Structure of Behavior New York: Holt, Rinehart and Winston, 1960.

Powers, W. T. Behavior: The Control of Perception: Chicago: Aldine Publishing, 1972.

Pribram, K. Languages of The Brain. Englewood Cliffs, N.J.: Prentice-Hall, 1971.

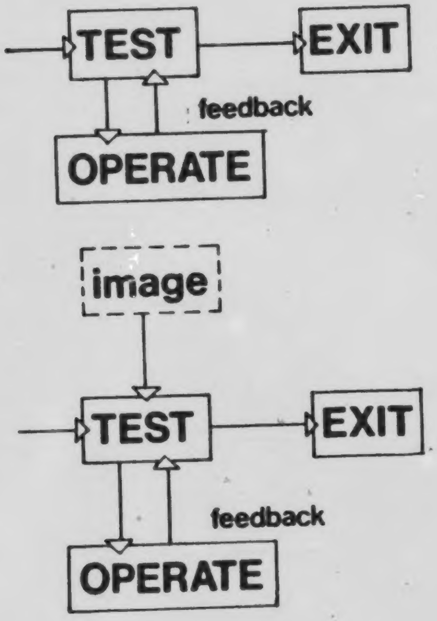

TEST
EXIT
feedback
OPERATE
image
TEST
EXIT
feedback
OPERATE

Figure 1. The TOTE Unit (After Miller, Galanter and Pribram, 1960)

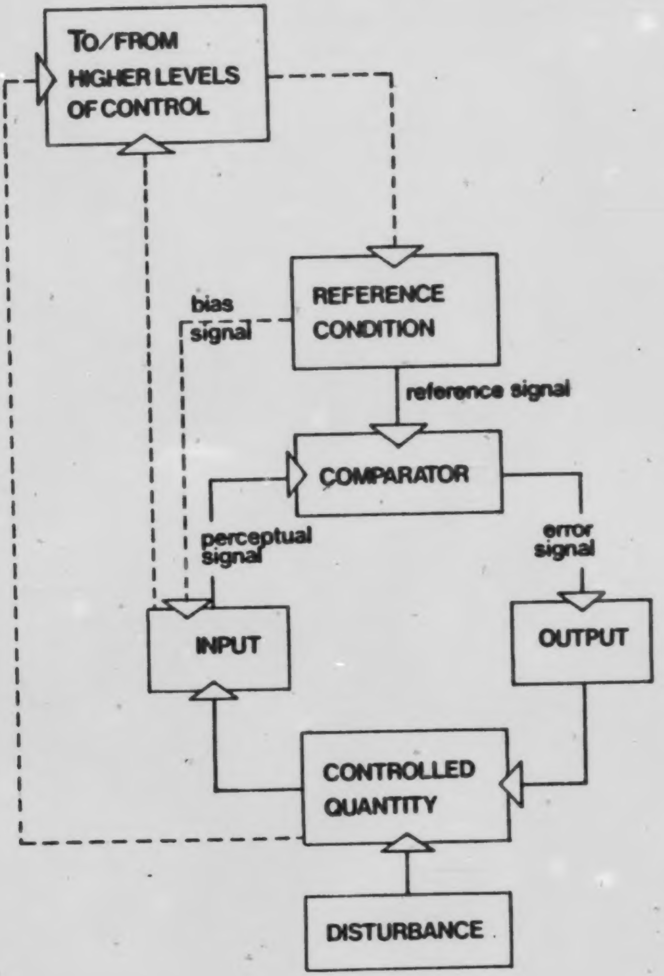

To/FROM HIGHER LEVELS OF CONTROL
REFERENCE CONDITION
bias signal
reference signal
COMPARATOR
perceptual signal
error signal
INPUT
OUTPUT
CONTROLLED QUANTITY
DISTURBANCE

Figure 2. General Model of a Control System and Its Local Environment (After Powers, 1972)

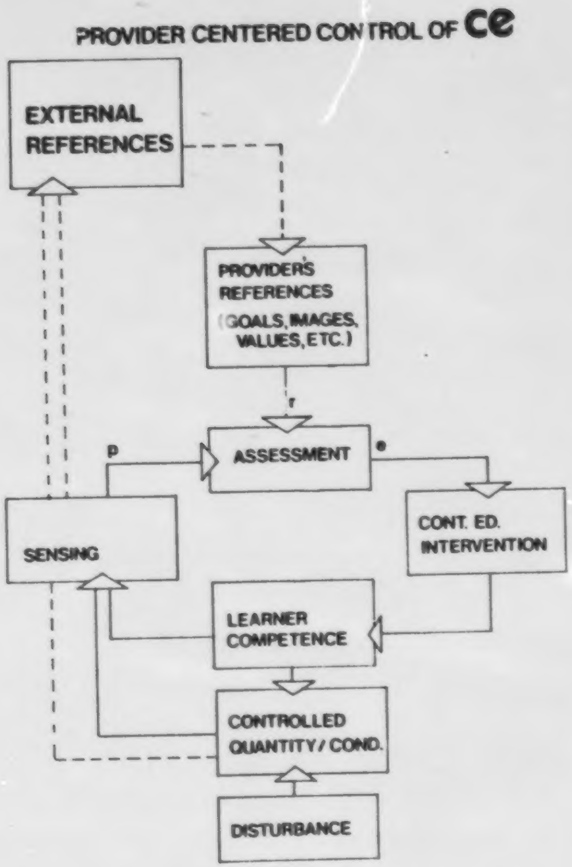

PROVIDER CENTERED CONTROL OF ce
EXTERNAL REFERENCES
PROVIDERS REFERENCES (GOALS, IMAGES, VALUES, ETC.)
r
p
ASSESSMENT
e
SENSING
CONT. ED. INTERVENTION
LEARNER COMPETENCE
CONTROLLED QUANTITY / COND.
DISTURBANCE

Figure 3. Provider - Centered Control of Continuing Education

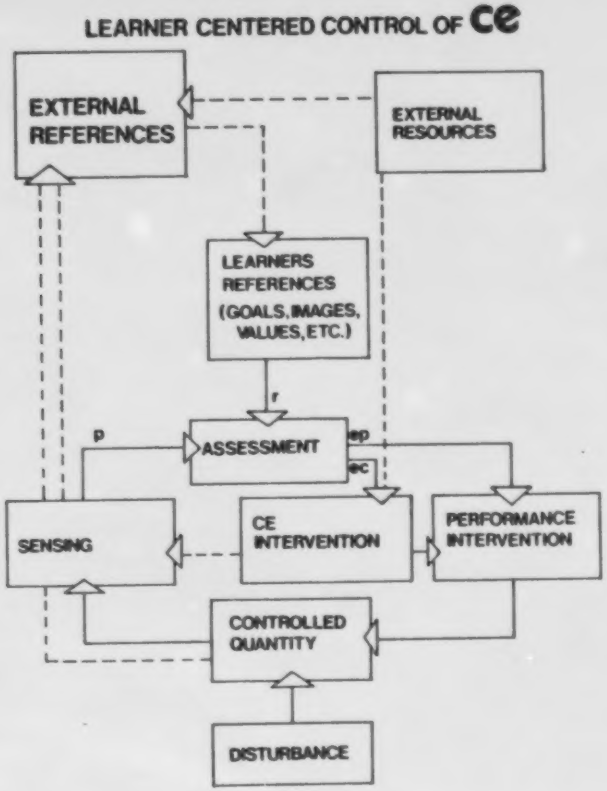

LEARNER CENTERED CONTROL OF ce
EXTERNAL REFERENCES
EXTERNAL RESOURCES
LEARNERS REFERENCES (GOALS, IMAGES, VALUES, ETC.)
r
p
ASSESSMENT
ep
ec
SENSING
CE INTERVENTION
PERFORMANCE INTERVENTION
CONTROLLED QUANTITY
DISTURBANCE

Figure 4. Learner - Centered Control of Continuing Education

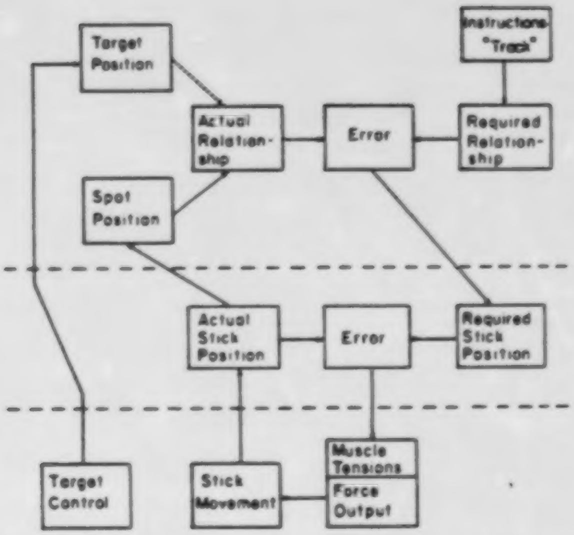

Target Position
Instructions "Track"
Actual Relationship
Error
Required Relationship
Spot Position
Actual Stick Position
Error
Required Stick Position
Muscle Tensions
Target Control
Stick Movement
Force Output

FIGURE 5.1. *A two-level model of feedback relationships in a tracking experiment.*

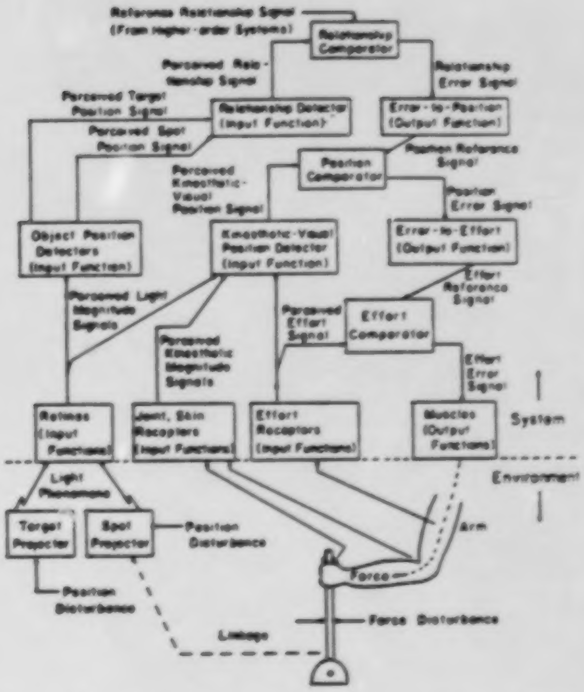

Reference Relationship Signal (From higher-order Systems)
Relationship Comparator
Perceived Relationship Signal
Relationship Error Signal
Perceived Target Position Signal
Relationship Detector (Input Function)
Error-to-Position (Output Function)
Perceived Spot Position Signal
Position Comparator
Position Reference Signal
Perceived Kinesthetic-Visual Position Signal
Position Error Signal
Object Position Detectors (Input Function)
Kinesthetic-Visual Position Detector (Input Function)
Error-to-Effort (Output Function)
Effort Reference Signal
Perceived Light Magnitude Signals
Perceived Effort Signal
Effort Comparator
Perceived Kinesthetic Magnitude Signals
Effort Error Signal
Retinas (Input Functions)
Joint, Skin Receptors (Input Functions)
Effort Receptors (Input Functions)
Muscles (Output Functions)
System
Environment
Light Phenomena
Target Projector
Spot Projector
Position Disturbance
Arm
Force
Position Disturbance
Force Disturbance
Linkage

FIGURE 6.1. *A three-level control-system model of a person in the tracking situation.*

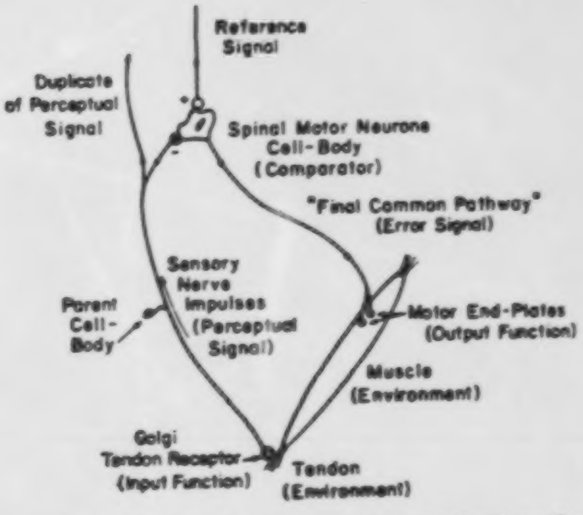

Reference Signal
Duplicate of Perceptual Signal
Spinal Motor Neurone Cell-Body (Comparator)
"Final Common Pathway" (Error Signal)
Sensory Nerve Impulses (Perceptual Signal)
Parent Cell-Body
Motor End-Plates (Output Function)
Muscle (Environment)
Golgi Tendon Receptor (Input Function)
Tendon (Environment)

FIGURE 7.1. *The basic first-order control system; the tendon reflex loop.*

Figures 5.1, 6.1, and 7.1 From Powers, W.T. Behavior: The Control of Perception, 1972.

TITLE: Research in Algorithmic Instruction:
Methodological Study

AUTHORS: Richard F. Schmid
Vernon S. Gerlach
Miroslav Valach

PLEASE MAKE COPIES OF THIS PAGE TO USE AS A COVER SHEET

COVER SHEET

Research and Theory Division Proposals
1980 ASSOCIATION FOR EDUCATIONAL COMMUNICATIONS AND TECHNOLOGY

Denver, Colorado

1. Title: Research in Algorithmic Instruction: A Methodological Study.

2. Author's Name:* Schmid (Last) Richard (First) F. (Initial)

*Give here the name of the person who will make the presentation or be our contact.

Affiliation: Concodia University-Montréal Phone: (514)879-4535

Mailing Address: Dept of Education 1455 de Maisonneuve Blvd. O.
Montréal, Québec Canada H3G 1M8

3. Program category for which paper should be considered: (underline the appropriate category and subcategory, if applicable)
   - A. Research Paper: Historical, Descriptive, Experimental
   - B. [✓ Conceptual Paper]: [✓ Theoretical], Position, Critical Review, Evaluation
   - C. Symposia
   - D. Research in Progress

4. If a symposium or panel proposal, list all other participants, institutional affiliations, and *complete addresses*, or if a contributed paper, list additional authors.

Dr. Vernon S. Gerlach
Arizona State University
College of Education, Box FLS
Tempe, AZ 85281

Dr. Miroslav Valach
Friday Computers
Palo Alto, California

5. Do you wish to have the use of audiovisual equipment? Yes X No ____
If yes, describe: Overhead projector

6. I hereby certify that this paper has not been submitted for publication, and if this paper is accepted and placed on the program, I agree to appear and deliver it in person. If unforeseen circumstances prevent my being present, I will arrange for a substitute person to deliver my paper.

Richard F Schmid (Signature) Nov. 20, 1979 (Date)

Please include the following with your proposal: (1) completed cover sheet; (2) 500-word summary (three copies without author identification); and (3) two self-addressed envelopes.

DEADLINE FOR SUBMISSION IS DECEMBER 1, 1979

Research in Algorithmic Instruction: A Methodological Study

Purpose

To describe a method of operationally defining levels of the independent variables in research on the instructional effectiveness of algorithms.

Rationale

The effect of algorithms in instruction has been reported in a significant number of studies. Authors such as Brecke, Gerlach, Landa, Reiser, Scandura, and Schmid have made presentations at AECT conventions. There is solid evidence to indicate that, for certain types of learning tasks, algorithms are facilitative. Generally speaking, they either increase efficiency or effectiveness or both.

Much of the past research has compared algorithmized instruction with some type of "traditional" instruction. It is not surprising that traditional instruction is often vaguely defined. Lack of precision in defining the control treatment or comparison treatment is characteristic of studies during the early stages of investigation of a new variable or a new level of a variable.

Furthermore, the independent variable "algorithm" has generally been treated as a more-or-less gross or unanalyzed variable. This, too, is generally characteristic of early studies of any new variable. Since these studies indicate that algorithms do produce predictable effects, programatic research demands that the independent variable algorithm be analyzed systematically in an effort to learn what attributes or characteristics of algorithms are producing the observed effects.

This paper presents a paradigm for conducting such research and describes one study in which this paradigm was applied.

Method

Computer terminology and modeling were employed in an attempt to precisely describe human algorithmic behavior. Following the lead of many contemporary cognitive psychologists (e.g. Anderson & Bower; Quillian; Simon), the components and the structural relations of teaching and learning algorithms were cast into a systematic model. Within the model, the concepts of an algorithm's depth and width, and the components' processing order as parallel or serial are defined and examples are presented. The model not only maps the logical order of events, but also allows the efficiency of various configurations to be calculated. Next the model's control activities are described, with special attention given to the level of synchronization of processing units or branches as well as the corresponding gate-keeping functions. Finally, the results of two experiments are compared with the model to ascertain its heuristic value.

Results and Discussion

Most importantly, it was found that use and retention of algorithmic problem-solving strategies are best dealt with in a serial fashion. It is also hypothesized that the length of the serial string must remain short and that the algorithms must be dealt with in "chunks" rather than a single unit. The dimension of the algorithm and the individual component's relations are easily described within the context of the model. A re-arrangement of the semantic content of the algorithm, a variable beyond the descriptive scope of the model, is also analyzed. Again in the domain of cognitive

research, it was found that the logic or familiarity of the content of the discriminators and operators has a profound effect on learning but that neither logic nor familiarity produces differential effects along a concreteness dimension in the training stage. Finally, the beneficial nature of this modelling procedure for instructional designers is discussed.

TITLE: Field-Dependence/Field Independence and
Instructional Development

AUTHORS: Dennis E. Sheriff

John A. Williams

title ● FIELD-DEPENDENCE/FIELD-INDEPENDENCE AND
INSTRUCTIONAL DEVELOPMENT

authors ● DENNIS E. SHERIFF
Chairman
Instructional Technology Programs
Northern Illinois University

● JOHN A. WILLIAMS
Doctoral Student
Instructional Technology Programs
Northern Illinois University

correspondence ● Dr. Dennis E. Sheriff
Faculty of Instructional Technology
Northern Illinois University
DeKalb, Illinois 60115

Field-Dependence/Field Independence and Instructional Development

In the past quarter of a century, Educational Technology has begun to play a vital role in the learning process not only in education, but in the private sector, government, and industry as well. One particular component within the content area of Educational Technology--instructional development--has become an important aspect of instruction. This component has yearned for a paradigm which could scientifically "match" a learner's cognitive style and the attributes elicited by instructional environments, materials, and media.

Thus, the primary purpose of the investigation was threefold: (a) To critically analyze Witkin's conceptualization of cognitive style gleaned from his field-dependence/field-independence continuum, (b) to identify cognitive style components within the instructional development literature, and (c) to construct a paradigm of the intersection and commonalities between the instructional development and field-dependence/field independence literature.

In order to deliniate Witkin's conceptualization of field-dependence/field-independence aspects of cognitive style, the researchers examined three areas: (a) Defining field-dependence/field-independence constructs, (b) enumeration of the characteristics and tests of field-dependent/field-independent subjects, and (c) the implications for educators derived from the research examined.

First of all, it must be noted that Witkin's conceptualization of cognitive style is based upon approximately thirty-five years of research, many times in collaboration with other individuals and researchers in the field; but in the beginning, was one of the first--along with Dr. Joseph Hill--who became famous for cognitive mapping.

Field-dependence, according to Dr. Witkin, "is the tendency to rely on external referents," while "field-independence is the tendency to rely upon internal referents." (Goodenough and Witkin, 1977, p. 2) This then, is a basic definition of the field-dependence/field independence construct.

Turning now to characteristics of field-dependent/field-independent aspects of cognitive style, they are as follows: (a) *Process variables*; in essence, what is perceived or learned is formulated from either a field-dependent or field-independent perspective, (b) *pervasive dimensions of individual functioning*, (c) *consistent over time* as well as across domains, (d) *bipolar*; while field-dependent subjects tend to stress interpersonal competencies and downplay cognitive restructuring, field-independent subjects tend to place an emphasis upon cognitive restructuring and downplay interpersonal competencies, and (e) *value neutral*; "it is not inherently better or worse towards one pole of the field-dependence/independence dimension or the other." (Witkin, 1977, pp. 23-29). In summary, according to Witkin, "cognitive styles are concerned with the form rather than the content of cognitive activity," and refer to "individual differences as to how we perceive, think, solve problems, learn, and relate to others;" in other words, a lifestyle. (Witkin, Moore, Goodenough, and Cox, 1977, p. 15).

The tests that were developed by Witkin and his associates were perceptual in nature: First, the Body Adjustment Test (BAT), where subjects are seated in a tilted chair in a tilted room and asked to align themselves with the upright, (Witkin, 1959, pp. 51-52); and second, the Rod and Frame Test (RFT), where subjects view a luminous rod centered within a tilted luminous frame and are required to align the rod with the gravitational upright. Those that utilize the external visual field are classified as being field-independent, while those who use the internal referent of their own body are classified as field-dependent. The third test of field-dependence/field-independence derives from perceptual and intellectual activities. It is entitled the Embedded Figures Test (EFT); a test by which subjects are asked to locate and/or break up a complex design in order to locate a hidden figure within the complex figure. (Witkin, Oltman, Roskin, and Karp, 1971, p. 3) Many studies have indicated that field-independence is a cognitive factor, commonly defined by EFT types of tests and which, in literature, has been known as disembedding. (Goodenough and Witkin, p.5)

Other tests have been developed to discriminate between field-dependence and field-independence (e.g. Gardner, Holzman, Klein, Linton, and Spence, 1959). These tests are as follows: (a) Imposition of organization on an impoverished stimulus array, (b) showing conservation in Piagetian tasks, (c) tests of conservation, and (d) performance on standard paper-and-pencil tests of spatial-visualization. All of these tests have been devised in order to accurately ascertain the preconceived learning style as derived from the field-dependence/field-independence continuum. The next area of research that was undertaken was the implications for education, particularly instructional developers regarding field-dependence/field-independence.

In reference to implications for education in general and instructional development in particular, there are many findings that were noted by Witkin in collaboration with Goodenough, Moore and Cox in Review of Educational Research, Winter, 1977. They are as follows:

1. Field-dependent students are "better at learning materials with social content."
2. There is "no significant difference regarding sheer learning ability or memory."
3. Studies have shown that "field-dependent persons are better at learning social material, when the material is peripheral to the task upon which they are concentrating."
4. "We may expect that field-dependent students would be more likely to require externally defined goals and reinforcements than field-independent students who tend to have self-defined goals and reinforcements." (p. 19)

5. "Field-independent students: learn more using intrinsic motivation conditions than field-dependent students."*

   *Caution: "this difference disappears when external rewards for learning are introduced, regardless of whether the rewards are material in nature or in the form of praise." (p.20)

6. "Field-dependence/independence may provide a useful basis for predicting which students are likely to be affected by what kinds of reinforcement."

7. Mediators in learning: (a) In many situations, field-independent people tend to behave as if governed by general principles which they have actively abstracted from their experiences; (b) Field-independent individuals learn when material is instructured and lacks organization; and (c) When material is organized, there are no differences in learning abilities.

8. Programmed instruction: Emmerich "found that field-dependent students profit from a plan while field-independent students profit less from this type of teaching approach."

In concluding this aspect, Witkin states that "beyond encouraging teachers to adapt their teaching to students as they find them, we may hope even more that teachers may find ways of helping students diversify their learning strategies."

Charles Eliot's investigation was the only investigation uncovered that made an attempt to link these two aspects and formulate a paradigm.

In his conclusions, he indicated that "learning might be optimized by using the learning characteristic of cognitive style as a basis of instructional design." (1976, p. 4)

Kathryn Martens also deliniated several implications derived from research entitled "A Descriptive Study of the Cognitive Style of Field Dependence-Independence in the New Student Population in the Community College." The results of her study "show that the cognitive style of field dependence occurs significantly more frequently in the new student sample than in the traditional or combined student samples." (Martens, 1976, p. 6)

The implications and recommendations for further research are deliniated by Martens as follows: (a) "Studies should be designed to determine the effect of various instructional strategies on the academic performance of students with differing cognitive styles;" (b) "Students should be helped to gain insight into their own cognitive style;" and (c) "Community college institutional research staff could establish testing programs for new students."

Witkin's work represents a major research effort involving the description of individual differences. Witkin has tried to organize these differences into a field-dependence, field-independence continuum, and has studied learner styles through perception. The approach has been to correlate various individual personality traits with his three standardized spatial perception tests for the purpose of better defining individual differences. Witkin's model is deficient in that the continuum does not allow for finite descriptions of individual differences and the tests are too cumbersome to administer to be practical for the classroom teacher.

J.P. Guilford has investigated learner styles through intelligence as contrasted with Witkin's studies of learner styles through perception. Another contrast can be drawn between the statistical treatment of the data afforded by each researcher. While Witkin utilized various correlational techniques, Guilford used factor analysis to generate his morphological model referred to as Structure of Intellect (Guilford, 1967, p. 63). While developing his factorial analysis of intelligence, Guilford saw that "any educational program based on the general objective (no matter how stated) of 'intellectual training,' requires a more competent and precise concept of the nature of intellect, and is what has been lacking" (1958, p. 152).

Guilford addressed his Structure of Intellect model (SOI) to the above need when he stated that:

> The new model promises to provide the kind of taxonomy that is needed. Before we can know how to improve intellectual abilities, we must at least know their properties. Such knowledge clarifies some of our tasks in selecting subject matter, in devising methods of instruction, and evaluating effects of learning. (1958, p. 152)

in later work, Guilford was advocating that education should return to an enlightened kind of formal discipline. He said, "When the nature of the generalized intellectual skills is known, we can select the kinds of exercises that should promote their growth" (1960, p. 66)

Although Guilford began his work with human intelligence in terms of verbal and non-verbal abilities, he was really attempting to identify and organize those abilities (factors) which had a significant effect upon student achievement. In a paper presented at the Seventh Annual Western Regional Conference on Testing Problems at the Seventh Annual Western Regional Conference on Testing Problems for the Educational Testing Service in Los Angeles, Guilford stated:

> . . . a knowledge of these intellectual factors and their properties should give us better ideas of how to educate for increased intelligence. This is true with regard to curriculum construction and also with regard to teaching procedures. We often set for ourselves the task of teaching students to think. Knowing the kind of thinking operations there are, we can find the subject matter that should involve those operations; and we should know how to induce exercise of them in students. (1959, p. 13)

Guilford made great pragmatic strides in relating intellect, content, and learning modalities along the three major axes of his SOI model. Each of these major axes is subdivided into smaller component parts, producing the potential of 120 separate factors.

Guilford (1967, p. 61) subdivided the dimension of content into four component parts: figural, symbolic, semantic, and behavioral. Support for the content dimension came from factor analytic studies of tests composed of both numbers and letters. These four factors should be considered when designing content for instructional purposes.

Operation was the second dimension of the model and represented the way in which students learned the content. This dimension consisted of five component parts: cognition, memory, divergent production, convergent production, and evaluation. Cognition was basic to the other four kinds of operations (Guilford, 1967, p. 63). At this point, cognition as defined by Guilford can be equated, with some degree of accuracy, to Murch's (1973, p. 64) discussion of the perceptual process. Potential stimuli that enter the sensory channel (vision, audition, taction, olfaction, or savory) are transported to the short-term memory. If cognition occurs, then the other components (memory, divergent production, convergent production, and evaluation) may be activated and the information can be processed, resulting in an end product known as "learning."

The product dimension of Guilford's model represented the way or form in which information occurs (1967, p. 63). This dimension has six component parts: units, classes, relations, systems, transformations, and implications. This dimension reflects the organization in which objects are presented to the student, and when tied to the operation dimension, represent the student's perceptual organization of information that is to be learned.

Collectively, this three-dimensional model represented the organization of human intelligence that is comples. Each of the 120 factors identified by Guilford are not discrete factors. Overlap within, between, and among the factors has been identified by Wiedermann (1973). Also, the complexity of the model is detrimental to practitioner oriented classroom utilization for the purpose of individualizing instruction. The determinants are influencing factors in man's interpretation of symbols and must be assessed when designing a meaningful and productive learning environment (Wasser, 1971, pp. 8-10).

Although historically and empirically the two approaches are different, functional similarities exist in that each is attempting to provide an explanation of how learners interact with the instructional environment. Both researchers have provided organizational "models" which, to some degree, describe learner styles. Each researcher has attempted to provide an explanation of the interaction between the student and the learning environment. Differences among the three models in terms of student "styles" can also be drawn. Witkin worked with perception and its relation to personality; Guilford with the relation and interaction of three components, intellect, content, and learning modalities. Witkin provided for individual differences in the form of a continuum, while Guilford described interrelationships among three components of intellect. Witkin used correlational techniques to perfect his three standardized tests. Guilford used factor analysis to generate his tests for categorizing types of intellectual abilities within his model.

In conclusion, the basic questions that an instructional developer must answer are: (a) Does matching for cognitive style make for better student learning? (b) How does matching or mismatching cognitive style work to produce the effect observed or ahcieved? (c) What are the roles of situational variables? (d) Does the learning of a particular kind of material favor a particular method, and does it override the effect of teacher/student differences in cognitive style?

The instructional developer's job then seems to be the task of matching learner styles with methodologies, presentation styles, learning environments, and goals and objectives. While this task does not on the surface seem difficult, the underlying assumptions have not been investigated. Thus, more research needs to be completed on the success or failure of these matches.

A word of caution! In a book entitled Accent on Learning, Cross emphasized the danger of matching student and teacher styles. She wrote that, "A consistent match of teaching strategy to student cognitive style may leave the college graduate unprepared to cope with nonpreferred strategies . . . in the real world." (1976, pp. 127-128). Hence, sporadic matching between student and teacher styles may be the more desirable approach.

REFERENCES

1. Cross, K.P. Accent on Learning. San Francisco: Jossey-Bass Publishers, 1976.

2. Eliot, Charles A. The effects of instructional designs matched to individual differences in cognitive styles on concept learning, a trait treatment interaction study. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, California, April, 1976. (ERIC no ED 122973.)

3. Gardner, R.W., Holzman, P.S., Klein, G.S. and Spence, D.P. Cognitive control: A study of individual consistencies in cognitive behavior. Psychological Issues, 1959, 1 (4Monograph 4).

4. Goodenough, D.K. and Witkin, H.A. Origins of the field-dependent and field-independent cognitive styles. Educational Testing Services, Princeton, New Jersey, July, 1977. (ERIC no ED 150155).

5. Guilford, J.P. A system of psychomotor abilities. American Journal of Psychology, 1958, 71, 151-174.

6. Guilford, J.P. New frontiers of testing in the discovery and development of human talent. In Seventh Annual Western Regional Conference on Testing Problems. Los Angeles: Educational Testing Service, 1959, 10-32.

7. Guilford, J.P. Three faces of intellect. American Psychologist, 1960, 14, 66-79

8. Guilford, J.P. The Nature of Human Intelligence. New York: McGraw-Hill, 1967.

9. Martens, K.J. A descriptive study of the cognitive style of field-dependence-independence in the new student population in the community college. Albany; State University of New York, 1976, (ERIC Document ED 140873)

10. Murch, G.M. Visual and Auditory Perception. Indianapolis: Bobbs-Merrill Company, 1973.

11. Wasser, L. "The educational science of cognitive style: An introduction." Unpublished manuscript, Oakland Community College, 1971.

12. Wiedermann, R.O.B. "Matching teaching styles to learner aptitudes within the structure-of-intellect model." Unpublished doctoral dissertation, Texas A&M University, 1973.

13. Witkin, H.A. The perception of the upright. Scientific American, February, 1959, 200, 2, p. 51.

14. Witkin, H.A., Moore, C.A., Goodenough, D.R., and Cox, P.W. Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, Winter, 1977, Vol. 47, NO. 1, 1-64.

15. Witkin, H.A., Oltman, P.K., Raskin, E., and Karp, S.A. *A Manual For The Embedded Figures Test*. Palo Alto, California: Consulting Psychologist Press, 1971, p.5.

TITLE: Linking Task Analysis With Student Learning

AUTHORS: Thomas M. Sherman

Terry M. Wildman

Linking Task Analysis with Student Learning

By
Thomas M. Sherman
Terry M. Wildman

College of Education
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

The current controversy surrounding task analysis, while not heated, may lead to some confusion. It appears to be widely recognized that some form of content structuring is an essential part of the instructional design process. However, there is little consensus on how content should be structured, what the proper focus of these structuring activities should be, how what is structured relates to what students must learn, or how any or all of the above relate to teaching practice or methods. There appear to be two major questions associated with these issues: 1) Exactly what is task analysis? and 2) What purpose does a task analysis serve? One difficulty in responding to these questions is that there are many correct answers depending upon one's position in the task analysis controversy. We will examine task analysis from several perspectives in order to identify some of the purposes and advantages of task analysis.

Task Analysis and Theory

As the interest in learning theory has shifted from a predominately behavioral perspective to a more cognitive orientation, so too has the role and purpose of task analysis shifted. In 1974 Gagne stated that "Task analysis was proposed as a method of identifying and classifying the behavioral contributors to task competence, for which differential instructional design was possible and desireable" (p. 3). This statement seems to imply a relatively straight forward series of contributors or component behaviors which could accumulate into a terminal performance. The reason for conducting a task analysis from this perspective rests on a relatively direct link between the behavior being taught and necessary instructional conditions. Identification of the component behaviors leads directly to the identification of instructional or learning conditions which effectively define necessary instructional activities. Gagne and Briggs (1974, pp. 148-149) included tables in their text on instructional design which coordinated the type of learning with these learning conditions.

However, cognitive and information processing theorists have not been so interested in the component behaviors as in the cognitive activity that occurs between these behaviors. As Resnick and Glaser (1976) stated, "It is probably not too extreme to argue that the most interesting events, in terms of a theory of intelligence, happen between the specified points in a hierarchy" (p. 207). Resnick (1976) defined task analysis as "the study of complex performances so as to reveal the psychological processes involved" (p. 51). In other words, the emphasis shifted from behavioral outcomes to the analysis of cognitive processes. This concern for process is evident in Winn's (1978) statement that "it is necessary for the designer to know the structural relationships between the concepts that form the content to be learned" (p. 4). While providing a richer theoretical understanding of learning, the cognitive approaches have been less than clear on how the analyzed processes may be linked with learning. In part, this is due to the variety of possible strategies any individual may employ in solving a specific problem. In part, the problem stems from the focus on identifying meritorious or expert processes rather than on specific instructional strategies leading to the learning of these processes.

The development of instructional materials or learning strategies has not been well described in most cases by cognitive psychologists. Frequently, the linking of content and learner is summarily passed over as when Winn (1978) stated, "The final design decisions leading to scripting materials to be produced, and decisions concerning the instructional strategies to follow are very similar to those followed in the traditional procedures of instructional development" (p. 15). It is difficult to believe that the fundamental changes in content analysis proposed by cognitive psychologists could be delivered in the same old or "traditional" way. In fact, they can't; it appears that a new catalog of instructional links are needed to teach processes rather than outcomes. The remainder of this paper will be devoted to an examination of three approaches to content structuring. In doing so, we will identify the explicit or implicit links which may be used to tie structured content to student learning.

Approach 1: The Optimal Content Structure Approach. Most information processing appraoches propose an expert or idealized model of the cognitive processes needed to perform a specific operation. The result is a detailed description of an "idealized performance - one that solves the problem in minimal moves, does little 'backtracking,' makes few or no errors (Resnick, 1976, p. 65). Content structures may be generated either empirically or rationally. The major difference is that the rational approach is derived from the inherent structure of the subject matter by an analyist. An empirical structure is a description of the process used by an expert to solve the problem. In both cases, the result of the analysis is an hypothesized structure which describes the necessary processes in a sequential order. A noteworthy example of an optimal content structure approach is Resnick, Wang and Kaplan's (1973) description of an hierarchy for a mathematics curriculum.

These analyzed structures represent an ideal arrangement of component processes and are ordinarily quite dependent on the skill of the analyzer. The resulting hierarchy represents one of several possible paths a learner may take in solving a problem all of which lead to a correct solution. In addition, the method selected to validate the hierarchy may also influence the obtained structure. Kurshan and Sherman (1977) found that three validating procedures (proportion of positive transfer; consistency, adequacy and completeness; and Guttman scaling) produced differing structures of the same component skills. The major problem, recognized by Resnick (1976), however, is that the teaching of the ideal routine or process may not be the best way to learn the process. Instead, it may be more productive to teach simpler routines from which learners generate more efficient and sophisticated routines.

The value of this sort of task analysis appears to be that "we can generally do a better job of accomplishing something and determining how well we have accomplished it when we have a better understanding of what we are trying to accomplish" (Greeno, 1976, p. 123). In other words, once the goal of instruction is clear, it is possible to identify several strategies that may be used to reach it.

The link between the ideal structure and learning, must be the teaching routine. Resnick (1976) discussed this problem as identification of "the connecting link between the structure of the subject matter and skilled performance - which is often so ellyptical as to obscure rather than reveal the basic structure of the task" (p. 74). Unfortunately, the specifics of this linking process are unclear and the best advice is quite general in nature. The best of this advice seems to be to present all strategies as alternative procedures and not as specific rules. That is, a process should be taught as a beginning point from which further learner elaboration and experimentation is expected. Perhaps this could be done by continually challenging students to invent and discover other strategies.

The instructional designer faces two problems; what to teach and how to teach it. The solution to neither problem is greatly facilitated by the optimal content structure approach. However, this form of task analysis does not greatly complicate the problem either. In fact, a well developed structuring of content could serve several purposes. At a curriculum guide level, an optimal content structure could provide a useful guide to teachers of the cognitive topography of the subject matter. While day to day instruction would not be impacted directly, the general purpose of instruction could be regularly directed toward the development of expert processes. At the daily instruction level, it would seem the best advice for linking the structured content to learning may be through the use of process models. Greeno (1976) gave a brief example of how this might be done in describing how he taught the process of proving congruent angles are equal (also see Greeno, 1978).

Approach 2: Learner - Content Match Approach. Faithful applications of Piaget's theory to instruction have been extremely rare. In two recent articles, Case (1976a, 1976b) has articulated some of the problems associated with the application of Piaget's theory and advanced a useful formulation for the development of instruction based on Neo-Piagetian ideas. The basic premise upon which this instructional approach is based is that the demands of the content must be consistent with the competence of the learner. Thus, there is a need to bring content and learner into harmony.

Case (1978a) identified two problems which must be solved in order to develop developmentally based instruction: 1) How may the development of operational structures be promoted? 2) How may content be adapted to the student's operational level? A three step instructional design process is proposed consisting of: Structural Analysis, Individual Assessment, and Instructional Planning. Structural Analysis is quite similar to an information processing analysis of the empirical sort. That is, the process used by an expert is analyzed into identifiable operations. The emphasis in structural analysis is on the competence that the learner must possess in order to perform or solve the problem. The second step, Individual Assessment, focuses on the identification of operations that the learner actually uses in solving the problem. The purpose for the assessment is to discover the incorrect strategy the learner employs while attempting to solve the problem. The procedure suggested for this analysis is the same as used during the structural analysis.

Step 3, Instructional Design, provides the link between the learner's current routine and the ideal routine as identified in Steps 1 and 2. Case focuses the instructional design on four potentially controllable variables drawn from Neo-Piagetian theory: M-power (the maximum number of independent schemes which can be attended to at any moment), the familiarity of the situation, the salience of cues to which the learner attends, and the number of items of information that must be coordinated. Five steps are included in this design process in order to arrange the above variables in an effective manner. The first is to "set up a paradigm where the subject may assess the effectiveness of the strategy that he currently employs" (Case, 1976a, p. 209). Here familiarity and cue salience should be maximized and cognitive complexity minimized in order not to confound the identification of the currently used strategy. The second step is to demonstrate to the learner the ineffectiveness of the strategy he uses. Step 3, involves helping the learner discover why his strategy is ineffective. Here the intent is to draw the learner's attention to the critical dimension (cue salience, familiarity, complexity) which must be attended to in order to solve the problem. The correct solution should be demonstrated and compared with the learner's incorrect strategy. Step 4 is to "facilitate (the learner's) construction of a more adequate strategy" (Case, 1976a, p. 211). The new strategy may be constructed spontaneously but more likely will need to be taught. The final step, is to consolidate and extend the new strategy through practice and feedback. Through practice the new strategy becomes "automatized" and requires less attention and energy during execution.

This link, while very complete, theory based, and well detailed; is quite cumbersome and tedious. Utilization of the instructional design process advocated would almost be disastrou a context where extensive pre-planning is required for instructional delivery. In fact, the instructional methods described by Case closely follow the clinical methodology techniques which have become synonomous with Piagetian theory. Clinical approaches to teaching are well suited to clinical settings but difficult if not impossible in regular instructional situations. Case (1976a) also recognized this problem and suggested that the procedure he described was, in fact, most applicable in clinical situations.

Relative to curriculum development this approach is not especially helpful since the major focus is on cognitive strategies. Curriculum design usually revolves around content and either an inherent or generated structure of that content. It is conceivable and even appealing to consider curriculum structured around cognitive strategies, but this appears to be unlikely since a major reorganization of education would be required.

Approach 3: Optimal Content Presentation Approach. Gehlbach (1979) criticized the ATI approach to theory building because of the prescriptive orientation generally pursued. He suggested a more generalizable approach where ATI are used as dependent measures and instructional methods are independent measures. Flat AT regression curves would be indicative of no interaction and identify "generally powerful" instructional treatments. In essence, Gehlbach suggested that ATI's be rendered impotent by exceptionally powerful instruction thus negating the differential effects of aptitude variations. Instructional strategies of this sort should provide instructors with very high levels of control over learning through explicitly defined teaching routines and regular student responses. In essence the focus of the approach is on the link rather than the content. Two examples of this approach are drawn from the work of Landa (1976) and Englemann (1980).

Engelmann (1980) did not address the issue of content structure; his approach may be more accurately described as instructional structure. The strategy is to structure the instruction in such a way that it cannot fail by attending to the instructional routine (the stimulus) rather than learner response as is traditionally done by behavioral psychologists. Engelmann (1980) presented five rules from which the effects of stimuli can be predicted on learner response:

> 1. Examples are classified as being the same in some way if they are treated in the same way by the teacher (labeled the same way).
> 2. Any observable sameness shared by all examples treated the same way describes a possible interpretation.
> 3. The set of teaching examples may describe only one interpretation or more than one interpretation.
> 4. Each interpretation implies classifying an indefinitely large number of "generalization examples" in a particular way.
> 5. The learner who receives a set of teaching examples will behave in a way that is consistent with one interpretation (Engelmann, 1980, p. 30).

Application of these rules should result in one of three outcomes: (1) if one example is taught, all learners will respond in the same way; (2) if more than one example is taught, each learner will respond to one of the interpretations; (3) generalizations may be expected to be consistent with the example(s) taught. Engelmann's point is that "the basic analysis for discriminations and concepts is performed on a set of examples, not the learner" (p. 32). Thus, the focus of analysis must articulate rules about the use of examples. The basic goal is to "construct sequences or routines that are consistent with a single interpretation" (p. 35).

Algorithms were defined by Landa (1976) as "instructions for the performance, in a particular order, of some system of elementary operations for solving all problems of a given class" (p. 77). Thus, knowledge of an algorithm enables a learner to correctly solve all problems within a problem domain. Since an algorithm is not a rule of itself but a description of the operations required to implement a rule, it may be thought of as a rule for using a rule. It is also, from an instructional design perspective, an operation which follows or is in addition to a content analysis. That is, the rules to be taught must be identified and ordered prior to the development of specific algorithms to implement or teach these rules.

The potential power of an algorithm in instruction is based on the high level of control established over learner information processing. At every stage of problem solution the instructor can match student production with the algorithm. Through practice, algorithmic problem solution becomes less of a step-wise process and more "simultaneous" (Landa, 1976, p. 93). Thus, the algorithm is the essential link between the learner and the rule to be learned. It is a highly structured, guaranteed and easily operationalized construct which will always lead to the correct solution.

In both examples, it is clear that the teacher is advantaged by the identification of specific linking strategies. What is unclear is the manner in which the content to which the strategies are applied may be identified. Perhaps a "traditional" task analysis would serve the purpose. It is also possible this would not be the case when non-algorithmic content or concrete concepts were not the focus of instruction (e.g. democracy or problem solving, Greeno, 1978). Regardless, the quest for powerful and well structured instructional stimuli is well worth pursuing.

Conclusion

It appears that the link between content and learning is dependent upon several factors which are not inherent in task analysis. The theoretical approach of the instructional designer appears to be a major determinant. For the theoretical approach plays a large role in the nature of the content included in the task analysis. One may legitimately focus on inherent content structure, learner capabilities, and/or instructional stimuli. However, two implications seem particulary noteworthy. First, it is imperative that task analysis be considered from a theoretical perspective. The theory appears to drive the whole instructional design process in that once a task analysis is completed, all subsequent instructional decisions should be consistent with the analysis approach. An understanding of theory may be the only way to generate such consistency. Second, structure of some sort is vital to successful instruction. If what is to be learned is not purposefully organized, generally lower rates of learning may be expected. Purposefullness appears to be a key issue in developing structure. That is, the content should be specifically structured to teach concepts and/or strategies and/or routines, etc. Failing to do so may result in students not learning what was intended. Finally, from all perspectives, it seems clear that there is agreement that task analysis, at a minimum, assists the instructor or designer understand the content to be taught. This alone is probably a sufficient reason for recommending the analysis and structuring of content. That is, the ultimate link may be that the teacher understands what he or she is teaching.

References

Case, R. Piaget and beyond: toward a developmentally based theory and technology of instruction. In R. G. Case (Ed.) Advances in Instructional Psychology, Vol. 1. Hillsdale, N.J.: L. Erlbaum, 1978a.

Case, R. A developmentally based theory and technology of instruction. Review of Educational Research, 1978b, 48, 439-463.

Englmann, S. Toward the design of faultless instruction: The theoretical basis of concept analysis. Educational Technology, 20, (February, 1980), 28-36.

Gagne, R. M. Task analysis - its relation to content analysis. Paper presented at the meeting of the American Educational Research Association, Chicago, April, 1974.

Gagne, R. M. and L. J. Briggs. Principles of Instructional Design. New York: Holt, Rinehart and Winston, 1979.

Gehlbach, R. D. Individual differences: Implications for instructional theory, research, and innovation. Educational Researcher, 8, April, 1979, 8-14.

Greeno, J. G. A study of problem solving. In R. Geaser (Ed.) Advances in Instructional Psychology, Vol. 1. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1978.

Greeno, J. G. Cognitive objectives of instruction: Theory of knowledge for solving problems and answering questions. In D. Klahr (Ed.) Cognitive and Instruction. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1976.

Kurshan, B. L. and T. M. Sherman. Validating hierarchial curricula: Advice or consent. Paper presented at the meeting of the American Educational Research Association, New York, 1977.

Landa, L. N. Instructional regulation and control. Englewood Cliffs, New Jersey: Educational Technology Publications, 1976.

Resnick, L. B. Task analysis and instruction. In D. Klahr (Ed.) Cognition and Instruction. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 976.

Resnick, L. B. and R. Glaser. Problem solving and intellegence. In L. B. Resnick (Ed.) The nature of intelligence. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1976.

Resnick, L. B., M. C. Wang, and J. Kaplan. Task analysis in curriculum design: A hierarchically sequenced introductory mathematics curriculum. Journal of Applied Behavior Analysis, 1973, 6, 679-710.

Winn, W. P. Content structure and cognition in instructional systems. 1978, ED 151 315.

TITLE: Instructional Media, Attitude Formation and Change: A Critical Review of the Literature

AUTHOR: Michael R. Simonson

TITLE: Instructional Media, Attitude Formation and Change: A Critical Review of the Literature

AUTHOR: Dr. Michael R. Simonson
Associate Professor of Secondary Education
321 Curtiss Hall
Iowa State University
Ames, Iowa 50011
(515) 294-6840

Paper presentation for the Research and Theory Division at the 1980 Annual Convention of the Association for Educational Communication and Technology, Denver, Colorado.

*Research for this manuscript was supported in part by a grant from the Research Institute for Studies in Education, College of Education, Iowa State University, Ames, Iowa.

INSTRUCTIONAL MEDIA, ATTITUDE FORMATION AND CHANGE

As early as 1931 Thurstone was investigating the influence of film on children's attitudes toward concepts depicted in the film. Specifically, opinions about the Chinese. Even at that early date the impact of the newer media on the more subjective components of learning such as opinion, liking and feeling were a concern. Thurstone (1931) found that film could change attitudes in both a positive and a negative direction. Since Thurstone's study many other researchers have investigated the relationship between attitudes and instructional media.

This review identified over one hundred forty of these media/attitude studies, and categorized them according to the type of media and type of attitude investigated. This categorization made it possible to determine if identifiable relationships existed between instructional media and attitudes of viewers.

Experiments dealing with three types of instructional media were found in sufficient quantity and quality in the literature to be included in this review. The media included were:

I. television,
II. motion pictures (primarily 16mm film), and
III. still pictures (filmstrips, slides, prints, filmographs).

Of primary concern to this review was the use of media in classroom instruction. This was at the exclusion of broadcast or mass communication applications of these media. Also, while not always possible, an attempt was made to include only experimental or quasi-experimental studies in the review according to criteria established by Campbell and Stanley (1963).

Attitude Defined In order to clearly establish parameters for the review process a set of definitions was established to guide search activities. Attitude was a difficult term to adequately define, primarily because it had been defined by so many, but also because of its many lay uses and connotations. However, for the purpose of this review attitude was defined as:

> A mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related (Thomas and Znaniecki, 1918).

Additionally, Zimbardo and Ebbesen (1970) divided attitude into three components: affect, cognition, and behavior. The affective component was said to consist of a person's evaluation of, liking of, or emotional response to some object or person. The cognitive component was conceptualized as a person's beliefs about, or factual knowledge of, the object or person. The behavioral component involved the person's overt behavior directed toward the object or person.

These definitions were operationalized for this review by dividing attitude/media research into two types--attitude toward the medium of instruction, and attitude toward content delivered by media.

The search process also necessitated a further sub-division of media/attitude experimentation. Generally, media/attitude researchers either examined a learner's attitude toward the medium (often referred to as liking), or attitudes produced in learners toward a medium after some instructional activity. A second type of attitude toward medium experimentation usually included a design that compared two groups of learners, one receiving instruction by the medium, the other by some other form (such as a lecture).

Similarly, when researchers investigated learners' attitudes toward content delivered by some medium they would usually examine either content-related attitude formation (liking) or attitude change produced as a result of the mediated instruction. For the purpose of this review these four types of attitude were used to categorize studies.
The types were:

- attitudes of learners toward a medium,
- comparisons of attitudes toward more than one media or method,
- attitude of learners toward content delivered by media, and
- attitude changes toward content produced as a result of mediated instruction.

Obviously, no category system is without mis-matches, but this grouping seemed to allow for the most logical discussion of studies (see Table 1).

The remainder of this review of the literature follows the organizational framework provided above and depicted in Table 1. Experimental studies concerned with each of the three types of media were reviewed in turn, beginning with television. Each review was divided into four subparts corresponding to the operationalized definition of attitude. A summary of conclusions was included as was a discussion of the design methodology of media/attitude research.

I. TELEVISION (TV)

More than sixty studies that examined the influence television instruction had on learner's attitudes were identified. These studies were categorized according to the type of attitude investigated, and each category was reviewed below.

A. Attitude Toward Television (Liking): Twelve studies examined the attitudes users had toward television (TV) as a mode of instruction. Generally, the studies in this category were not experimental, but rather were one-time evaluations of opinion that asked those involved in televised classroom instruction to rate their reactions toward this method of teaching.

Five studies reported TV users who were generally favorable toward this mode of instruction. Jacobs and Bollenbacher (1960) reported that in a 1960 administration of an attitude scale toward a TV course on biology the students were more favorable toward TV than were students in 1958. Westley and Jacobson (1962,a) found that a group of teachers they sampled were highly favorable toward TV as a mode of instruction. Neidt (1967) reported that university students "liked" TV lessons on study skills they saw, and Dambrot (1972) found that college psychology students had slightly above-neutral reactions toward TV, even though these TV attitudes were slightly lower than those toward the course in general. Vandermeer (1961) discussed a study by Hunt that evaluated the use of fifteen televised lessons on the teaching of reading. Both teachers and parents indicated a significantly favorable attitude (liking) toward television as a mode of instruction.

Three studies reported results where learners indicated a negative feeling toward televised instruction. Colle and Albert (1958) surveyed one hundred sixty-two teachers who did not use television in their teaching and found that only 5% approved of TV as a mode of instruction (50% disapproved and 45% were undecided). There seemed to be a relationship between familiarity and approval. Bobren (1960) found that student attitudes toward a TV course were negative on nine of eleven questionnaire scales. Larimer and Sinclair (1969) polled students in a course taught using a two-way television link-up between instructor and class. Students reported a negative attitude toward the class.

Several researchers attempted to evaluate the reasons for the inconsistent reactions toward television expressed by TV users. Westley and Jacobson (1962,b) conducted a second study on teacher's attitudes toward television as a method of instruction. They found that teachers who had used TV in their own classes were significantly more favorable toward this technique than were teachers who had not used television. Toch (1960) also examined whether familiarity with television had a relationship to liking of this medium. Results were inconclusive but did show a relationship between those who indicated they approved of educational television and those who actually chose to watch an educational program. Neidt (1964) found a "Hawthorne effect" in operation when television was used in classroom situations. Learner's attitudes toward television tended to decline as TV was used more in the classroom. Klapper (1958) found that liking could be influenced according to the way information was presented via television. Highly visualized lessons, in contrast to lessons showing only an instructor and blackboard, produced strongly favorable attitudes toward television in viewers.

Generally, results reported above tended to be somewhat inconclusive and sometimes contradictory. Probably the attitude (liking) developed in viewers of instruction delivered by television depended on more than just the medium. Variables such as familiarity with medium, amount of visualization, quality of production, and utilization techniques may have been crucial in developing favorable or unfavorable attitudes in learners toward TV as a method of delivering instructional information.

B. Comparisons Between TV and Other Modes:

Another procedure for determining student's attitudes toward televised instruction was attempted by researchers who compared two groups of learners who received the same content by two modes--television and some other, usually the conventional lecture/discussion. Greenhill, Carpenter, and Ray (1956) attempted to ascertain students' preferences for televised instruction by having one group of students receive five weeks of face-to-face instruction and then five weeks of televised teaching. The other group received similar instruction but in the reverse order. Students were then allowed to choose the type of learning situation they wanted to continue receiving. Seventy-one percent chose TV, even though only 51% indicated they preferred televised instruction.

Champa (1958) divided science students into three treatment groups (conventional instruction, TV supplement to instruction, and TV/film supplement), and found that students favored the use of TV or TV/film "almost unanimously." A similar study was conducted by Westley (1963). Ninth grade math students received information by television or conventional instruction. At the conclusion of the year-long course the students in the TV group rated their mode of instruction more positively than did the conventional instruction students. Morrison (1967) compared dental students' attitudes toward instruction after half had received instruction by television and half conventionally. Attitudes toward instruction were significantly more favorable for the TV class.

One researcher (Janes, 1964) attempted to identify what correlated with learners' preferences for television and found that self-confidence and intelligence correlated significantly with preference for television. Neidt (1968) compared attitudes toward instruction expressed by learners who were taught by one of four modes. This study reported that programmed instruction had the most favorable rating, followed by televised instruction, small class and large class.

Contradictory evidence to the favorable results reported above was also found in the literature. Macomber, et. al. (1958) reported that college students generally preferred conventional class situations to televised instruction. Bobren and Siegel (1960) described a study that compared attitudes of five sections of engineering students taught conventionally to five sections taught by television. The TV students had relatively more negative attitudes than the traditionally taught students. Woodward (1964) found that college biology students preferred conventional instruction to television. Additionally, two studies (Tannebaum, 1956; and Davis and Johnson, 1966) reported no significant differences between the attitudes of viewers of a televised presentation and a live one.

It would seem, then, that preferences for televised instruction were probably dependent on some other variable, or variables, than merely mode of instruction. Holmes (1959) stated this as a general conclusion of a study conducted to analyze the trends of results in television research. Holmes concluded that the attitudes of students toward television could probably be more accurately described as attitudes toward other elements involved in the teaching-learning process, such as the instructor, the situation, and the content. A study in the Cincinnati Public Schools (1959) gave support to this contention when it reported that different ability students tended to react differently to biology instruction by television.

Based upon the results reported above, there did not seem to be any conclusive trends in the literature supporting the hypothesis that televised instruction is either favored, or disliked, by students. One generalization that seemed to be supported was that the content of an instructional presentation probably played a more important role in the liking of delivery mode than did the delivery mode of the instruction itself.

C. Attitude Toward Content of TV Instruction: Eighteen studies were identified that attempted to determine if students demonstrated any liking of, or preference for, the content presented in televised lessons. Again, results were fairly evenly divided between those studies where learners preferred TV-delivered content and studies where no preferences were reported.

Eight studies produced results where viewers of televised instruction indicated a positive attitude toward the content delivered by TV. Two of these eight studies compared televised instruction to some form of control or non-television teaching. Westley and Jacobson (1963) found that ninth grade TV students had more favorable attitudes toward math than non-TV students. Coldevin (1975) found that all four variations of a TV lesson produced more positive attitudes toward the content of the lessons that attitudes produced in control subjects. The TV treatment that repeated information 5 seconds after each subunit of the televised lesson (for student response and involvement) produced the greatest positive attitudes in subjects.

The six other experiments that reported positive results merely evaluated viewers' attitudes toward the content of a television presentation and reported conclusions. Hunt (1961) found that teachers who watched 15 half-hour television programs on individualizing reading instruction developed positive attitudes toward this topic. Kihava, et.al. (1961) reported that television lessons favorably affected Japanese students attitudes toward science. Skinner (1967) used televised science lessons with variations in the method of on-tape subject presentation and post-tape follow-ups. Results reported that interest in science improved, with the largest positive gains for girls. Dambrot (1972) gave an attitude scale to 2900 college psychology students and found that a slightly more positive than neutral reaction to a TV course was reported by subjects. Six videotaped science lessons were developed by Galey and George (1974) and shown to first grade students in order to motivate them to continue science experimentation. Results indicated the videotaped lessons were successful. Piper and Butts (1974) found that after seventy-six science teachers participated in a televised science in-service program the teachers reported having significantly more favorable attitudes toward science than before the sessions began.

Contradicting the results reported in the studies reviewed above were the results of ten experiments where negative or neutral reactions to televised information were reported. Seven of these eleven reported no significant differences between attitudes of subjects who saw a television presentation and those who viewed similar information presented in some other way. Kumata (1958) found no difference in attitudes toward social science course content for TV or non-TV students. Jacobs and Bollenbacher (1960) reported that students' attitudes toward science were not different for four classes of varying ability levels either taught by television or taught conventionally. Garry (1960) reported similar no-difference results in a study that evaluated attitudes toward science of fifth grade students.

Walton (1963) compared the attitudes toward course content of college students who viewed either a live presentation or closed-circuit TV and found no significant differences between groups. Backens (1970) reported that subjects who received instruction by the conventional method had significantly more positive attitudes toward a mathematics course than did subjects who saw closed-circuit versions of the lecture, even when follow-up sessions were provided for the TV treatment subjects.

A television course in physical science for ninth graders was compared to instruction that was not televised by Welliver (1967). Attitude results were not significantly different. Sims (1968) compared subjects' attitudes toward geography after two groups received either television instruction or live classroom lecture/discussion. No significant differences in attitude toward geography were reported. In a similar study, Levine (1973) compared closed-circuit television instruction to traditional lecture/recitation and found no significant differences between subjects' attitude toward chemistry. A study by Ganschow, et.al. (1970) compared videotaped to audiotaped instruction on vocational education. While over-all attitudes toward this topic were not different, it was found that subjects who saw social models of an ethnic group like their own tended to score more positively on attitude measures toward the occupation of the model they viewed.

Booth and Miller (1974) attempted to evaluate television's impact on attitude formation by showing color and monochrome versions of the same lesson. They found an age/color interaction. Primary grade students tended toward more positive attitudes for monochrome presentations while color was found to be a positive factor in promoting levels of valuing in the upper elementary grades.

It would seem apparent from the results reported that merely televising a lesson did not necessarily promote positive attitudes toward the content of the lesson, and often produced negative reactions in viewers. Negative attitudes toward course content seemed to be very likely for subjects who were required to view closed-circuit, or videotaped replays, of live lectures. Variables other than delivery mode probably were most important in determining students' attitudes toward instructional content.

D. Attitude Changes Toward Content of TV Presentations: Possibly one of the most powerful techniques for determining the influence of television on the content-related attitudes of viewers was attempted by researchers who developed television treatments designed to change existing attitudes of viewers. The studies in this category evaluated techniques for altering attitudes toward some instructional topic through the use of televised presentations.

Twelve studies were found where televised treatments were, in varying degrees, successful in altering pre-existing, content-related attitudes of viewers in the desired direction. In 1959, Asher conducted a simply designed experiment to determine if attitude changes toward the main concepts depicted on a television program could be produced, and if change was a function of source credibility (national network versus local educational station), or predictable from a viewer dogmatism scale rating. Attitude changes were produced, but neither source or dogmatism data provided significant conclusions.

Lottes (1960) reported that a series of fifteen televised lessons on the individualization of reading instruction were successful in positively changing reading teachers' attitudes toward that topic. Weldon (1962) conducted a similar study that evaluated the impact of a twelve-hour television course on adults' attitudes toward civil defense. Experimental subjects reported significantly positive attitude changes toward civil defense, as compared to control subjects. Environmental education was the topic presented by television in a study conducted by Wright (1971). Results showed a signficant positive attitude change toward environmental education as a result of televised treatment procedures. Menzies (1973) reported that violent attitudes of prison inmates were positively (made more violent) influenced by three forty-five minute violent television treatments, as compared to non-violent TV, and that there was a multiplier effect apparent. O'Brien (1973) reported the results of an experiment where only urban students' attitude changes toward the topic of problem solving were positively influenced by a televised presentation. Rural students' attitudes were more influenced by a conventional lesson. It was hypothesized that viewers of persuasive information need to identify with the communicator in order for attitudes to be influenced, and since the rural students identified with the real instructor, but not the televised message, they were not as susceptible to television as were urban students.

Croft (1969) and Donaldson (1976) designed their studies to evaluate subjects' reactions to televised instruction as compared to control groups, but also as compared to subjects viewing a live message. Croft wanted to change the audience's attitude negatively toward intercollegiate athletics. Results indicated that a televised message was successful in changing viewers' attitudes, but not as powerfully as those changes produced by the "live" communication. Donaldson's results were similar. A televised communication on the disabled was successful in changing college students' attitudes toward disabled people as compared to control subjects, but viewers of a live presentation had greater positive changes. Both Croft (1969) and Donaldson (1976) hypothesized that TV was not as powerful as a live communication because TV had fewer informational cues (ie. was not as "realistic").

Several researchers evaluated not only the impact of televised messages on attitude change, but also whether variations in the type of TV presentation would have a varying impact on attitudes. Seiler (1971) designed an experiment with four treatments. Each of the three experimental groups viewed a television version of a persuasive speech on the Vietnam War. One group's tape had technical visuals such as graphs and charts interspersed on its videotape. Another group had "human-interest visuals," such as photographs, on its videotape. The third group saw only the speaker. Both of the "supplemented" versions produced significantly greater attitude change than the other treatment. The visuals were thought to add more information, and to increase the credibility of the message.

Kraus (1962) took a slightly different approach. In this study on attitudes of whites towards Negroes the race of the two communicators was varied. Greatest positive race-related attitude changes were produced as a result of treatments where both races were represented, as compared to all-white or all-black communicators. Possibly, the message was perceived as being more credible in this instance. Amirian (1962) found that significant, positive, science-related attitude changes were produced when televised lessons were supplemented with follow-up assignments.

An experiment conducted by Kraemer, et.al. (1975) also evaluated the way a televised message was presented in order to evaluate the type of attitude changes produced. They found that including a role-playing actor on a videotape who reacted favorably to the persuasive communication (race relations, in this case) was as successful in producing desired attitudinal changes in viewers as was the filmed message presented alone, and that both procedures produced significant attitude changes, as compared to the control treatment.

Contradictory results were also found in the literature. The conclusions of five studies indicated that attitude changes were not produced as a consequence of a televised communication. A study by Meyer and Gute (1972) evaluated the affect of channel variation on attitude change and source credibility. There were no differences in attitude change reported between groups who received a persuasive message either by video, audio, or live, as compared to each other or a control group. Evans, Wieland and Moore (1961) reported that a single TV presentation of a controversial educational program did not significantly alter viewers attitudes toward the controversial topic (prejudice), as compared to control subjects' attitudes.

Bickel (1964), Field (1972), and Browning (1975) reported the results of studies where desired attitude changes were not found in viewers of televised instruction. TV versus live (Bickel, 1964), film versus color TV versus monochrome TV (Browning, 1975), and color TV versus monochrome TV (Field, 1972) were compared, and no significant attitude changes were reported.

Several researchers attempted to more completely explore procedures for using television to deliver messages that would successfully change the content-related attitudes of viewers. Keating and Latane (1972) found that when intermittent distractions (2-second decrease in video signal by 20db, twenty times during a persuasive speech) were added to a televised message there was a significant positive change in attitudes as compared to subjects who viewed the speech with no distractions or a continuous distraction. It was theorized that the intermittent distractions acted to inhibit viewers' counter-argumentation, increased their involvement, and lowered their defenses to the counter-attitudinal message presented on the videotape.

Simonson (1977) and Goldman (1969) evaluated the impact of commitment and involvement of subjects in making of videotapes on attitudes. Simonson found that by inducing students to commit themselves on videotape to a counter-attitudinal position their attitudes would shift in the desired direction. Goldman reported that microteaching (videotape recording of self while teaching) significantly altered education students' attitudes toward self and teaching.

When the results of experiments designed to change content-related attitudes were evaluated collectively it seemed obvious that televised messages were often successful in producing desired affective outcomes. It also seemed obvious that television alone did not account for these changes. Attitudinal outcomes were produced when television presentations were designed to bring about those changes, just as cognitive outcomes can be produced in well developed lessons. If a persuasive message was produced that maximized the capabilities of the television medium, and that incorporated some theory of attitude change, (e.g. communicator credibility), then desired attitude alterations in the viewers of that lesson were probably found. However, if television was improperly used, or used only to vary the channel or method of message delivery, then desired attitudinal outcomes were probably less likely to be found. In the domain of attitude formation and change, television's impact seemed to be similar to the impact it has in the cognitive domain. If correctly planned, produced and used, televised instruction will be liked, will promote interest in the message it delivers, and will be successful in changing attitudes.

II. MOTION PICTURES (FILM)

Research concerned with the relationship between motion photography (film) and attitudes was identified and reviewed by applying the same categorization system as that used for television research. Over fifty studies were collected. While there were many similarities reported between the motion media (TV and film), there were also many production, visual, and utilization differences found that might have produced conclusions different from those reported in the television literature concerning the impact of motion photography on attitudes.

A. Attitude Toward Film: Generally, researchers reported viewers of film enjoyed it as a communication mode (Lange, et.al., 1956; Redemsky, 1959; for example). However, when film was used as the basic instructional method the reactions of viewers were less likely to be so uniformly positive. Wittich et.al. (1959) reported that science students became interested in science after viewing films but they did not "look forward to seeing the films." As a partial reaction to the mixed opinions of instructional film viewers, several researchers attempted to determine the characteristics of instructional films that tended to be valued positively by viewers. This was done in order to prescribe techniques that would make teaching films more likely to be favorably received by students.

Greenhill and McNiven (1956) were able to determine that the more useful a learner perceived the information presented in a film, or the nearer he/she felt they were to the people or objects depicted in a film, the more favorably they would react to the film, and learning would be increased. Knowlton and Hawes (1962) found that a positive attitude about film as a method of teaching and learning was significantly correlated with knowledge about instructional uses of motion photography. Redemsky (1959) reported that if a specific procedure for the showing of a film (one that included preview and review discussions) was used, most students reacted very favorably to motion photography as a method of instruction.

B. Comparisons Between Film and Other Modes: A few studies were identified that attempted to determine viewers' liking for instructional film by comparing units taught by motion photography with some other method of teaching. Ganschkow, et.al. (1970) reported that vocational education students reacted more favorably to filmed instruction than to the same information presented in written form. Champa (1958) conducted a study that evaluated attitudes toward TV and film when they were used to teach ninth grade science. Results indicated pupils favored the use of TV and film "almost unanimously."

Two studies compared a film to a filmograph (still pictures of film scenes) version of the same script. Miller (1969) hypothesized that film motion would increase the emotional involvement of viewers and produce positive attitudinal responses. Results supported this hypothesis. However, a study conducted by the U.S. Army (Instructional Film Research Program, 1954) reported that there was no difference in attitudes produced toward film or filmograph versions of a presentation on military police support for emergencies.

Similar inconclusive results were reported by Hayes (1966). Students' attitudes toward instruction were not significantly different between those taught driver's education conventionally and those taught using film.

Weisgerber (1960) conducted a large-scale experiment involving the use of science motivational films in several grade levels of two schools. Neither junior high or high school students were more favorable toward filmed instruction than they were toward conventional instruction that used factual rather than motivational science films.

An interesting adaptation of the use of film in teaching was evaluated in a study conducted by Erickson (1956). In this experiment students actually produced a film in one class. Students in the film-making group reported that they enjoyed this technique for learning science more than students in a conventional treatment.

Generally, results seemed to indicate that students enjoyed filmed instruction and had favorable attitudes toward this medium. While the small numbers of attitude-toward-film studies reviewed made definitive conclusions of a general nature impossible, it did seem that film was more often favorably valued than not, and was generally more positively valued than televised instruction. Probably the single most important reason for this was the fact that most classroom films were commercially made and were technically excellent, while many TV lessons were locally prepared, not as well done, and therefore not as favorably received.

C. Attitude Toward Content of Filmed Instruction: The basic form of content-related film/attitude research involved assessing the reactions of viewers to information presented by motion pictures. While generalizable conclusions were not readily apparent, the results of the several studies reviewed in this category did provide some interesting insights into the liking of the content of filmed instruction expressed by viewers, even if these insights were not exactly definitive. As early as 1933, Charters had summarized several studies that evaluated the impact of film on attitudes of children. It was found that desired attitudinal outcomes were produced, but multiple showings of a film tended to confuse viewers' attitudes.

Rizik (1974) wanted to determine if a film on rehabilitation counseling would produce positive attitudes toward that topic in college students. Results indicated that subjects felt positively about this topic after viewing the film. Wittich, et.al. (1959) also reported positive affective reactions to film. These attitudes were expressed by subjects who viewed the 162 thirty-minute films making up the Harvey White Physics Film Project. Experimental subjects reported greater positive interest in science than did non-film viewing control subjects. However, no differences in science interest were reported by Noall and Winget (1959) in a study evaluating the same physics film series. Weisgerber's (1960) study of interest toward science as influenced by motivational films reported that while junior high school students were not significantly influenced by the films, high school pupils were.

Smith (1973) compared attitudes of sociology students toward either film-only instruction or conventional instruction. Post-tests of attitude toward the courses tended to demonstrate that the film-only students were more positive about sociology, but statistically significant results were not obtained. Even more negative results were reported in one study that found that unfavorable reactions toward physics and chemistry were produced in viewers of films, as compared to conventionally taught students. These results were reported as part of a project evaluation conducted by Popham and Sadnavitch (1960).

Several researchers attempted to evaluate the film medium to determine how it could be used more effectively to promote liking of the messages carried by motion pictures. Donohue (1973) found that political advertisements were perceived more favorably in color than in black and white. Greenhill & McNiven (1956) concluded that students valued the content of a film more positively if they perceived a usefulness for the content of the motion picture, and if they identified with the characters or events depicted on the film. Weisgerber and Coles (1971) discovered that while different racial groups did not react differently to films on "self-image" there were mixed feelings expressed by several ability groupings of subjects.

In summary, there did not seem to be general conclusions apparent from the studies reviewed in this section. In some cases subjects reported significantly favorable attitudes toward the content of instructional films. In other cases, no differences, or negative reactions, were reported. It would seem likely that there were intervening variables that exerted an influence on the impact a filmed message had on the message-related attitudes of viewers.

D. Attitude Changes Toward the Content of Filmed Instruction:

Landmark studies conducted in the 1930's (Thurstone, 1931; Peterson and Thurstone, 1933) demonstrated the potential impact of motion pictures on the social attitudes of children. Since then, attitude change has been frequently studied by film researchers. More than thirty studies were found in the literature that evaluated the ability of filmed presentations to alter existing attitudes of viewers.

Thurstone (1931) found that two versions of a motion picture about the Chinese produced either favorable or unfavorable attitudes in children, depending on the intent of the message presented in the film. Peterson and Thurstone (1933) reported on a series of experiments that used motion pictures to alter the attitudes of elementary and secondary students' attitudes toward topics such as nationality and race, crime, punishment of criminals, capital punishment and prohibition. They reported that motion pictures had a definite, lasting effect on the social attitudes of children, especially younger children, and that the viewing of a series of films on the same topic seemed to have a cumulative effect on the attitudes of viewers.

Since the 1930's, when these studies were conducted, there have been a substantial number of other research studies that have verified the impact of filmed messages on attitude changes. Levonian (1960, 1962, 1963) published a series of articles that described the processes used to develop a persuasive film on India. Levonian administered a questionnaire to the target audience and analyzed the responses to this instrument in order to develop the script for the persuasive film on India. Results of the final study (1963) showed that the film produced as a result of the data collected from the questionnaire was successful in significantly changing the attitudes toward India of viewers of the motion picture.

Winick (1963) reported that a film on drug addiction, "The Man With the Golden Arm", produced a shift in attitudes of viewers in the direction of a more permissive attitude toward the narcotics addict, as compared to controls. Greenberg (1963) evaluated the attitudinal impact of two films with identical visual content but opposite narratives. One film claimed communism was active in the U.S. while the other took the opposing position. Results indicated that attitudes toward communism were stablized in viewers of the first motion picture. Subjects who watched the second film developed strongly negative attitudes toward the group that advocated that communism was playing an active role. This was the position presented in the narration of this film version. Another study (Hanson, 1968) reported that a color film on the necessity for parental involvement in the development of normal speech habits of their children produced an attitude change in parents in the direction advocated in the motion picture.

An interesting adaptation of the use of persuasive films was presented in a study by Rogers (1973). This experiment evaluated the impact of public health films on attitudes toward cigarette smoking, safe driving, and venereal disease. Rogers found that the more noxious the film was the more fear that was aroused in the viewer. However, it was also found that attitudes of viewers of films on these topics were changed most dramatically when the motion picture either gave effective preventatives, or convinced the viewer of the likelihood of exposure to the malady depicted in the film.

Another group of studies that reported positive attitude changes in the viewers of films were those that included some type of post-film discussion or follow-up in the experimental design. Allison (1966) reported that positive attitude changes toward the film topic science were only produced after viewing ten motivational films accompanied by follow-up discussions. Burrichter (1968) found that attitudes toward continuing education were positively changed in viewers of films who also participated in lectures and discussions on this topic. In a study by Domyahn (1973) a non-persuasive film on America's responsibility for the fall of Eastern Europe after World War II was used with various types of post-viewing critiques and discussions. Significant attitude changes were produced in viewers of the film who also participated in a persuasive critique. Fay (1974) also used follow-up discussions after experimental subjects saw a film on the need for the design of barrier free buildings. Attitudes toward this topic were significantly changed.

Four additional studies were found in the literature where filmed treatments were used to positively change attitudes toward the topics presented by motion pictures. Greenhill (1957) reported on a study where a film on the mentally retarded was used to shift some personality scale responses of viewers. Alese (1973) also evaluated the impact of a film about mental retardation, and reported a small but significant change in attitude toward acceptance of the mentally retarded in viewers of the motion picture. Reid (1970) evaluated the impact of two versions of a presentation about the church. Both the traditional film version and multi-image version of the presentation were successful in changing attitudes of viewers toward the church in one of two situations. Incidental instruction in the form of two films, a lecture, class discussion and a hall display were found to be successful in changing attitudes of junior high students toward the problem of overpopulation (Sourers, 1973).

A final study (Buvinie, 1976) was found in the literature that reported positive attitude changes in viewers of a filmed treatment. This experiment evaluated the aggression heightening effect of a violent film scene on college men. Results indicated that the aggressive motion picture significantly heightened the strength of a film viewer's written attack on a partner, as compared to viewers of a non-aggressive film. Aggression occurred only if evaluation immediately followed viewing. It was theorized that this heightened tendency towards aggression was produced as a consequence of viewing the film scene.

A somewhat smaller number of studies were found that reported non-significant attitudinal changes in viewers of persuasive motion pictures.

During the 1940's McFarlane (1945) was attempting to use motion pictures to change children's attitudes toward other races, and while significant results were not obtained it was found that "story" films that were realistic to children were probably better at changing attitudes than "non-story" films. Kishler (1950) found that college students who viewed persuasive motion pictures with a main character who had an occupation/position with a high prestige value for them tended to change their attitude in the direction advocated by the character. However, experimental results were not significant.

Spigle (1956) conducted a study on attitude changes of high school boys toward the armed services. Results were conflicting. While most viewers of the motion picture changed in their attitudes toward the military, they did so in opposite directions. The motion pictures seemed to have caused those who were originally less favorable to become more favorable, and those who were more favorable to become less favorable.

Mental health films shown to prison inmates did not produce all predicted changes in attitudes even when group-centered psychotherapy sessions were included, according to results reported by Greenhill (1957). A similar inconclusive outcome was discussed in a study conducted by Merrill and McAshan (1960). This study was conducted to produce attitude changes toward traffic safety as a result of viewing a persuasive film. Even though considerable pre-production analyses were conducted before the motion picture was produced, similarly to what Levonian (1963) attempted, the predicted attitude shifts were not produced.

Merrill (1962) concluded that defensive avoidance prevented alteration of attitudes as predicted in viewers of "attitude films" that used dramatic plot and characters to alter social attitudes. Similarly, Wickline (1965) found no significant changes in attitude toward science produced in experimental subjects who viewed weekly motivational films on science.

Two additional studies were found in the literature and neither reported desired attitude shifts resulting from film treatments. Sullivan (1964) found no differences between attitudes of high school girls who viewed persuasive films on college and those who did not. Bond and Rosing (1973) showed a film on hunting to mentally retarded subjects and found changes in attitudes that were opposite to those hypothesized.

In spite of the fact that many researchers were able to produce attitude changes in viewers of persuasive motion pictures there were a smaller but sufficient number of experimenters who used similar procedures, but who were not able to produce attitude changes (e.g. Levonian, 1963; as compared to Merrill and McAshan, 1960; for example). Attempts to find solutions to the inconsistency of reported results were made by several researchers. Miller (1969) attempted to discover if film motion had any influence on the emotional involvement of viewers, and thus the production of attitude changes. A filmograph was compared to a film on the same topic. Results supported the hypothesis that the motion picture version would produce significantly greater attitude changes than the still pictures. Browning's (1975) two by three design (ability by film, color TV, or black and white TV) did not produce any significant attitude differences or interactions toward the topic of nutrition. Morin (1976) attempted to ascertain if skin color or speech patterns of the actor in a film would affect racial attitudes. No significant differences were reported.

One unique experiment that did produce significantly different attitude changes was conducted by Schwartz (1970). Three treatment groups were included in the design of this study. Each group saw the same film, but the sound track was altered to either support, glorify, or contradict the anti-war theme of the motion picture. Attitude change in the direction advocated by the film were produced when the sound track was glorifying or supporting, but not when it was contradictory.

E. Summary: Obviously, no conclusive statements about the impact of film on attitudes should be made. Results of studies reviewed were not uniform enough. However, some general implications were apparent. It would seem that viewers like films, and like to learn from motion pictures, at least as well as other forms of instruction. It also would seem that subjects' attitudes toward the content of films was often quite positive. Viewers valued information presented by motion pictures. Additionally, attitude changes were more often than not produced in viewers of persuasive films. Motion pictures were found to be a powerful tool for delivering controversial messages, especially when extreme care was used during planning, production, and utilization of the film. In short, motion pictures would seem to have been a viable mechanism for delivering information when attitudinal outcomes were important.

III. STILL PICTURES

Still media (slides, filmstrips, filmographs, and photo essays) were not evaluated and written about in the research literature in as great a quantity as was experimentation on film and television. Twenty-three studies were found that evaluated the impact still visuals had on the attitudes of viewers. The absence of motion in the presentation of visual information was the most obvious difference between this medium and the TV/film media. Evaluations of research on still media were included in this review to provide as complete a discussion of the media-attitude relationship as was possible.

A & B. Comparisons of Still Photography to Other Media: Three studies were found that reported positive reactions by students toward instruction by still media. Vander Meer (1961) reported "highly favorable" reactions of students toward posters and tape recordings as a method of teaching. Crist (1967) compared written programmed instruction (PI) to programmed frames projected one frame at a time with a 35mm slide projector. It was reported that students who used the projector were more positive about their instructional mode than were the traditional PI students. Hempstead (1973) studied reactions of sixth graders to five types of mediated presentations (print, verbal sound, print with pictures, print with verbal sound, and pictures with verbal sound). Results indicated that pupils preferred print or pictures with verbal sound, and that subjects in these treatments had the most positive attitudes toward the learning experience, as compared to subjects in other treatments.

Two experiments attempted to determine if pictorial embellishments on still slides improved the attitudes of viewers toward the slide medium. Results were contradictory. Baker and Popham (1965) reported that those subjects who saw an embellished version of a slide presentation were more favorable to the presentation than were viewers of unembellished slides. A later study by Popham (1969) did not report any significant preferences for embellished slides by viewers.

Filmograph versions of motion pictures reported in section II (Instructional Film Research Program, 1954; and Miller, 1967) seemed to provide weak support for the hypothesis that motion versions were a preferred method of instruction to still versions of the same script.

Thus, it would seem that while still media pictures were favorably received in certain instances, there were other instances reported where information was depicted more positively by motion media. Actually, there were an insufficient number of studies reviewed in this category to develop any conclusive opinions on the medium-related attitudes of learners.

C. Attitude Toward Content of Instruction from Still Media: Nine studies were identified in the research literature that evaluated the impact of still visuals on the content-related attitudes of learners. Only one study (Vickers, 1972) reported positive results. It was found that students who were taught English using a large number of overhead transparencies and worksheets had significantly more positive attitudes toward that topic than controls. However, results were suspect because subjects were not randomly assigned and different instructors taught the control and experimental groups.

Four researchers reported no significant differences as the result of experiments that evaluated attitudes toward content delivered by still pictures. Reeser (1972) used a slide presentation, booklets, and lectures to present information on the construction industry, and while results were not significant, the slide subjects did possess the most positive attitudes toward the subject. Kolmos (1970) designed a study that compared attitudes of college students toward statistics after receiving instruction from 35mm slides either in study carrels or in the classroom. Control subjects received lecture instruction. No significant differences in attitudes toward content were reported. Another study reported that eighth grade mathematics students did not change in their attitudes as a result of filmstrip instruction, and were not significantly different from students traditionally taught (Wilkinson, 1971). Watts (1974) reported no significant differences toward sex education for students taught by slides, lecture, or independent study.

Four experiments were identified that attempted to evaluate the characteristics of still pictures when they were used as a method of instruction. This was to determine if these characteristics had any impact on the attitudes of viewers. Two studies (Winn and Everett, 1978; and Katzman and Nyenhuis, 1972) compared black and white slides to color slides. Katzman and Nyenhuis reported that a color slide presentation produced more positive affective reactions in viewers, but only two of the several attitudinal comparisons made were significant. Winn and Everett reported that color did seem to influence affective meaning, and that younger subjects were more positively influenced by color than older subjects.

Ainsworth (1970) varied the frequency of still visual change for either five, three, or one second intervals. Each slide was viewed for a total of ten seconds, but there were no attitude differences produced that seemed related to frequency or time of viewing. Miller and Roberts (1965) conducted a similar study to several reported by film and television researchers, but with slides. They developed two versions of a slide presentation but varied the race of the actor depicted. It was found that the viewer characteristic "closed-mindedness" exercised the greatest influence on attitude toward the message presented. The most negative attitudes were expressed by closed-minded individuals exposed to the black actor.

Results of studies reported in this section did not seem to provide support for any hypothesis related to the positive or negative impact of still media on content-related attitudes of learners. Few significant findings were reported. Possibly the informal nature of the classroom use of slides, filmstrips, or transparencies contributed to this lack of definitive conclusions.

D. Attitude Changes Toward Content of Still Picture Presentations

Six experimental studies were found in the literature that were designed to determine if attitude changes could be produced as a consequence of instruction from still pictures. Five of the six studies reported desired attitude changes.

One of the earliest studies involving mediated materials and attitude change was conducted by Janis and Feshbach in 1953. This experiment involved the use of "fear-arousing" slide presentations with appeals of varying strength about the perils of poor dental hygiene. Results indicated that the slide presentations were effective in producing desired affective responses in viewers, but that minimal appeals were more effective than stronger, fear-arousing appeals. Janis and Feshbach concluded that this was because a strong appeal increased the likelihood that the audience would be left in a state of emotional tension, and if this tension was not fully relieved by the reassurances contained in the message the audience would tend to ignore or minimize the importance of the threat. This conclusion seemed to support those offered in the study by Rogers (1973) that evaluated the effects of fear-arousing films on attitudes.

Allen (1968) also reported results of a study that supported results found in other media/attitude experimentation (Skinner, 1967; Allison, 1966; and Burrichter, 1968; for example). Allen's study reported that a slide presentation was effective in changing the attitudes of culturally disadvantaged students, and that these changes were most likely to occur when students were allowed to actively participate in, and respond to, the message. Also, low intelligence, less knowledgeable students were most susceptible to attitude change. Jouko (1972) reported similar results in a study on social studies attitude change. There was a negative relationship found between amount of attitude change and pre-instruction familiarity about social studies.

Litcher (1969) conducted an experiment with possible implications for the textbook industry. Results supported the hypothesis that the use of multi-ethnic pictures in textbooks would produce positive race-related attitude changes in students who used them. Last, Piersma (1974) found that attitudes toward Africa were successfully changed through the use of an audio-visual presentation on that topic.

Only one study was found where still pictures were unsuccessful in producing desired attitude changes. Smith (1972) reported that a filmstrip/tape presentation designed to alter teachers' attitudes about behavioral objectives did not produce any uniform attitude alterations even though different personality types seemed to be influenced differently by the presentation.

E. Summary: Because of the small number of studies found and reviewed that examined the impact of still pictures on attitude formation and change, few conclusions can be proposed. It does seem that still media did not produce as large a percentage of favorable reactions in viewers as did television and film. The exception to this generalization was in the area of attitude change. It did seem that still media instruction was successful in producing desired attitudinal changes in viewers, and these positive outcomes were most likely to be found when the still media was designed, produced and used properly. This finding supported similar conclusions reported in the television and film sections of this review.

IV. EVALUATION OF PROCEDURES USED IN MEDIA/ATTITUDE RESEARCH

Without attempting an in-depth analysis of research and research design, there seemed to be four prevalent characteristics of the media/attitude research reviewed in this paper that prompted a critical questioning of the results and conclusions offered. These design faults seemed somewhat unique to this area of educational research, and not as typical of other forms of instructional experimentation. Certainly, these deficiencies were not found in all, or even most of the studies reviewed. However, these problems occurred often enough so that they should be considered when research conclusions are offered, and should be avoided when future experimentation in this area is planned.

A. Definitions: Apparently, attitude was a difficult concept for researchers to adequately define. Actually, attitude was used as such a broad, all-inclusive term that a single definition for all studies would not have been adequate. However, it is imperative in future research that whenever "attitude" is measured the experimenter must define what is meant by that term in the specific research situation under study. This operational definition should be based on attitude literature and should be clearly stated for the research consumer. A common fault of the research reviewed above was the failure by experimenters to operationally define what was meant by attitude.

Additionally, much of the media/attitude experimentation reviewed seemed to have been designed in a theoretical vacuum, especially the attitude change studies. There seemed to have been little effort at relating attitude hypotheses or results to any theoretical framework.

In fact, many researchers failed to include any review of attitude research in the literature sections of their studies. It would seem imperative that future media/attitude research should carefully draw upon the literature of attitude change and perception theory, for example, when experimental studies are developed.

B. Measurement: It has been said that an experimental treatment is only as good as the measure used to determine its success. The measures used in studies reported above often seemed to be faulty. In over fifty percent of the reviewed studies no standardization of the attitude measurement tool appeared to have been attempted. Fewer than twenty percent reported any descriptive information about their attitude tests. Most measures seemed to have been locally prepared and intended for use only once--in the specific study reported.

C. Design: Many studies reviewed that were conducted prior to Campbell and Stanley's (1963) publication on research design did not use generally accepted experimental procedures when testing attitude hypotheses. This was to be expected. What was of greater concern was the poor design and control procedures used in more recent studies. The problem was compounded by the fact that attitude measurement was often not of primary concern to the researcher, but rather was a post-hoc analysis that had peripheral importance and connection to the main purposes and design of the study. Attitude hypothesis testing should demand the same design rigor as the testing of any experimental question.

D. Follow-up: Long term follow-up of the results of treatments was almost uniformly nonexistent in the attitude research reviewed. Many critics of attitude research consider attitudes to be transitory and attitude changes short-lived. While there is some evidence to refute this criticism in the psychological literature on attitudes, the long term consequences of mediated instruction on learner attitude needs additional evaluation.

Obviously, when the problems described above permeate a body of research it is difficult to identify relationships or trends. However, it is the opinion of this reviewer that in several categories the quality and quantity of research efforts allows for the development of fairly concrete conclusions by the reader. The foundations for the review summaries provided in the following section of this paper were based on this substantial number of high quality experiments.

V. SUMMARY AND OPINIONS

The very nature of educational research often prohibits the development of conclusions that can be widely applied to a variety of situations. This review tended to uphold that limitation of research in general and especially in the specific area of instructional media and attitudes. In every category of review there were substantial numbers of studies that offered contradictory results. While the percentages of positive, or predicted, results reported were often very high in many categories, the obvious inadequacies of many experimental designs, coupled with the numbers of non-significant findings, prohibited the reviewer from developing any prescriptive conclusions about the relationship between media and attitudes. As a matter of fact, it would seem to this reviewer that only one, broad, general conclusion concerning the relationship between media and attitudes was apparent and that this conclusion was a most obvious one. Instructional media is primarily a carrier of information, and plays its greatest role in the teaching/learning process as a delivery mechanism. Characteristics of media and mediated instruction, such as flexibility of use, accessibility of materials and equipment, and relationship of content characteristics to specific media characteristics, for example, were probably most important in determining affective outcomes in learners (or cognitive ones, for that matter) in the studies reviewed. Any inherent communication-related characteristics of a given form of media were probably of secondary importance in the determination of attitudinal outcomes.

However, a reviewer would be just as remiss in his/her mission by not offering the reader opinions about how to interpret review information. A careful examination of the experimental research reviewed above does foster certain "research opinions" in the reviewer. These opinions, while certainly not definitive, might possibly be valuable in providing guidance for future researchers interested in this area. Also, it was obvious that there were a large number of successful studies that used techniques valuable to the researcher as well as to the developer of mediated instruction. The synthesis of such information was stated in the terms of "Research Opinions". These "opinions" were annotated by citing those studies that supported each.

I. Research Opinion - General

Instructional media materials that were most likely to produce positive or desired attitudes in learners were those that were specifically planned for this purpose and that included procedures or activities designed to influence all three of the components of attitude (affective, cognitive, and behavioral; Zimbardo and Ebbesen, 1970).

A. Methods of positively influencing the affective component of attitude:

Specific Opinion #1 - "Realistic" media (with many visual cues, for example) seemed to be preferred and "liked" by students (Ganschow, 1970; Katzman and Nyenhuis, 1972; Booth and Miller, 1974; for example). In other words, realistic situations depicted realistically seemed to be highly regarded by viewers of mediated instruction.

Specific Opinion #2 - Technically "well-done" materials that were specially designed seemed to be valued highly by learners (Levonian, 1960, 1962, 1963; for example).

B. Methods of positively influencing the cognitive component of attitude:

Specific Opinion #3 - Students seemed to react more favorably when "new" information was presented in a persuasive communication, or in a mediated lesson (Knowlton and Hawes, 1962; Allen, 1968; Jouko, 1972; for example).

Specific Opinion #4 - Younger students seemed to be most likely to react favorably to mediated instruction when it was presented realistically, possibly because new information was being presented to them (Peterson and Thurstone, 1933; Winn and Everett, 1978; for example).

Specific Opinion #5 - Information presented by some credible source, or in a credible manner, tended to be valued most favorably by viewers (Kishler, 1950; Seiler, 1971; O'Brien, 1973; for example).

C. Methods of influencing the behavioral component of attitude:

Specific Opinion #6 - Students who were actively involved in the planning and/or production of mediated instruction seemed to be favorably directed towards the medium used, and toward the message delivered (Erickson, 1956; Simonson, 1977; for example).

Specific Opinion #7 - When students were involved in the delivery of mediated instruction, such as by answering questions, or by participating in the sequencing of materials, they seemed likely to be positively affected (Kraus, 1962; Goldman, 1969; Coldevin, 1975; for example).

Specific Opinion #8 - When follow-up discussions and critiques were used in conjunction with mediated instruction, students tended to react favorably toward the medium and content discussed, and were more likely to change attitudes in desired directions (Allison, 1966; Skinner, 1967; Burrichter, 1968; Domyahn, 1973; Fay, 1974; for example).

Specific Opinion #9 - Any technique of design, production, or delivery that increased a viewers emotional involvement was likely to produce desired attitudes or attitude changes, if there was ample opportunity during the instructional situation for the student to alleviate the arousal produced. This alleviation should have been related to the attitude position desired or advocated (Janis and Feshbach, 1953; Miller, 1969; Rogers, 1973; for example).

II. Research Opinion - General

Merely converting a message from one media delivery type to another usually had little positive affect on the attitudes of learners toward the instructional activity, or the content presented, and often had an adverse influence on the attitudes of learners. There was no "best" medium for influencing attitudes (Walton, 1963; Backens, 1970; Meyer and Gute, 1972; Levine, 1973; for example).

Depending on the reader's frame of reference, mediated instruction either greatly influenced, or did not greatly influence the attitudes of students. If mediated instruction was defined to include the entire learning process of which television, film or still pictures were a part, then those media did seem to contribute to the attitude formation and change of viewers. If only the media themselves were evaluated, then conclusions were much less conclusive. It would appear that mediated instruction was only one variable operating during the process of forming or changing attitudes, and that media played a role of varying importance, depending on the specific situation under study.

TABLE 1. CATEGORY SYSTEM FOR REVIEW OF MEDIA/ATTITUDE EXPERIMENTS

Medium		Attitude Category A. Toward Medium	B. Comparisons To Other Methods	C. Toward Content	D. Changes Toward Content	Totals
	I. Television	12*	13	18	20	63
	II. Motion Pictures	6	7	10	33	56
	III. Still Pictures	8 (combination of A and B)		9	6	23
						142

* Number of studies in this category

REFERENCES

Ainsworth, T. D. Frequency of visual change in multi-channel communication as a factor in maintaining attention and creating attitudes to media and message: an experimental study (Doctoral dissertation, University of Southern California, 1970). Dissertation Abstracts International, 1970, 31, 3158A.

Alese, Joseph. Operation awareness. Mental Retardation, 1973, 11(5), 38-39.

Allen, W. et.al. Effects of audiovisual materials on changing the attitudes of culturally disadvantaged students. Los Angeles: University of Southern California, 1968. (ERIC Document Reproduction Service No. 020 298)

Allen, W. H. Research on new educational media: summary and problems. AV Communication Review, 1959, 7, 83-96.

Allison, R. W. The effect of three methods of treating motivational films upon attitudes of fourth, fifth and sixth grade students toward science, scientists, and scientific careers (Doctoral dissertation, Pennsylvania State University, 1966). Dissertation Abstracts, 1966, 28, 994.

Amirian, G. T. The retention by elementary school children of natural science material and of science attitude and interest changes following a program of science teaching by television (Doctoral dissertation, Boston University, 1962). Dissertation Abstracts, 1962, 23, 2414.

Aquino, C. C. Teacher attitudes toward audiovisual instructions as they are influenced by selected factors within teaching environments. AV Communication Review, 1970, 18, 187-195.

Asher, J. J. An investigation of some aspects of the social psychological impact of an educational television program. Journal of Applied Psychology, 1959, 43, 166-169.

Backens, V. W. The effect of teaching beginning mathematics by television (Doctoral dissertation, North Texas State University, 1970). Dissertation Abstracts International, 1970, 31, 5143A.

Baker, E. L. & Popham, W. J. Value of pictorial embellishments in a tape-slide instructional program. AV Communication Review, 1965, 13, 397-404.

Becker, S. L. The relationship of interest and attention to retention and attitude change. Iowa City, Iowa: University of Iowa, 1963.

Bickel, R. E. A study of the effect of television instruction on the science achievement and attitudes of children in grades four, five and six (Doctoral dissertation, Syracuse University, 1964). Dissertation Abstracts, 1964, 25, 5777.

Biekert, R. G. An experimental comparison of two methods of teaching numerical control manual programming concepts: Visual media versus hands-on equipment (Doctoral dissertation, Arizona State University, 1971). Dissertation Abstracts International, 1971, 32, 1315A.

Bobren, H. M. Student attitudes toward instructional TV: Additional evidence. *AV Communication Review*, 1960, *8*, 281-283.

Bobren, H. M. & Siegel, S. L. Student attitudes toward closed-circuit instructional TV. *AV Communication Review*, 1960, *8*, 124-128.

Bond, J. H. & Rosing, A. *Measuring attitude change response to films*. Syracuse, New York: Syracuse School District, 1973. (ERIC Document Reproduction Service No. ED092 104)

Booth, George D. & Miller, H. R. Effectiveness of monochrome and color presentations in facilitating affective learning. *AV Communication Review*, 1974, *22*, 409-422.

Browning, R. E. Relationship of visual presentation modes to content mastery and attitude by sixth-grade pupils (Doctoral dissertation, University of Southern California, 1975). *Dissertation Abstracts International*, 1975, *36*, 1252A.

Burrichter, A. W. *A study of elementary public school personnel attitudes toward continuing education in selected communities in Wyoming; an experiment in changing adult attitudes and concepts*. Unpublished doctoral dissertation, University of Wyoming, 1968.

Buvinie, M. & Berkowitz, L. Delayed effects of practical versus unpractical responses after observation of movie violence. *Journal of Experimental Social Psychology*, 1976, *12*(3), 283.

Caldwell, R. M. *A comparison of a programed text and a computer based display unit to teach reading skills to semi-literate adolescents*. State College, Pennsylvania: The Pennsylvania State University, 1973.

Campbell, D. T. & Stanley, J. C. Experimental and quasi-experimental designs for research on teaching. In N. L. Gage (ed.), *Handbook of Research on Teaching*. Chicago: Rand-McNally, 1963.

Champa, V. A. Television: its effectiveness in 9th grade science teaching. *AV Communication Review*, 1958, *6*, 200-202.

Chapman, T. H. *Simulation game effects on attitudes regarding racism and sexism* (Research Report No. 8-74). College Park, Maryland: Maryland University, (Cultural Study Center), August 1974.

Charters, W. W. *Motion pictures and youth: a summary*. New York: MacMillan, 1933.

Cincinnati Public Schools. *Report of three experiments in the use of television in instruction* 1958-1959. Cincinnati, Ohio: Cincinnati Public Schools.

Coldevin, G. O. Spaced, massed, and summary as review strategies for ITV production. *AV Communication Review*, 1975, *23*, 289-303.

Colle, R. D. & Albert, R. S. College teachers' attitudes toward closed-circuit TV instruction. *AV Communication Review*, 1958, *6*, 116-123.

Crist, R. L. Role of peer influence and aspects of group use of programmed materials. *AV Communication Review*, 1967, *15*, 423-434.

Croft, R. G., Stimpson, D. V., Ross, W. L., Bray, R. M., & Breglio, V. J. Comparison of attitude changes elicited by live and videotape classroom presentations. *AV Communication Review*, 1969, *17*, 315-321.

Dambrot, F. General psychology over closed-circuit television. *AV Communication Review*, 1972, *20*, 181-193.

Davis, R. H. & Johnson, C. F. *Evaluation of regular classroom lectures distributed by CCTV to campus and dormitory classrooms*. East Lansing, Michigan: Michigan State University, 1966. (ERIC Document Reproduction Service No. ED 021 468)

Domyahn, R. A. The effects of a non-persuasive film, a specially designed persuasive critique, and a non-persuasive group discussion on attitude and retention of information (Doctoral dissertation, University of Iowa, 1972). *Dissertation Abstracts International*, 1973, *33*, 6586A.

Donaldson, J. Channel variations and effects on attitudes toward physically disabled individuals. *AV Communication Review*, 1976, *24*, 135-144.

Donohue, T. R. Viewer perceptions of color and black-and-white paid political advertising. *Journalism Quarterly*, 1973, *50*, 660-665.

Earle, H. F. Student attitudes toward geometry (Doctoral dissertation, University of Maryland, 1972). *Dissertation Abstracts International*, 1972, *34*, 1059A.

Eigen, L. D. High school student reactions to programmed instruction. *Phi Delta Kappan*, 1963, *44*, 282-285.

Erickson, C. W. H. Teaching general science through film production. *AV Communication Review*, 1956, *4*, 268-278.

Evans, R. I., Wieland, B. A., & Moore, C. W. The effect of experience in telecourses on attitudes toward instruction by television and impact of a controversial television program. *Journal of Applied Psychology*, 1961, *45*, 11-15.

Fay, F. A. Effects of a film, a discussion group, and a role playing experience on architecture students' attitudes, behavioral intentions and actual behavior toward barrier free design (Doctoral dissertation, University of Illinois, 1974). *Dissertation Abstracts International*, 1974, *34*, 6445A.

Field, H. H. The effect of color versus black and white instructional television on attitude change toward subject matter and retention of subject matter (Doctoral dissertation, University of Maryland, 1972). *Dissertation Abstracts International*, 1972, *33*, 1973A.

Frey, S. H., Shimabukuro, S., & Woodruff, A. B. Attitude change in programmed instruction related to achievement and performance. *AV Communication Review*, 1967, *15*, 199-205.

Galey, M. & George, K. Development of the skills of classification using television. *AV Communication Review*, 1974, *22*, 153-166.

Ganschow, L. H., et.al. *Stimulating educational information seeking and changes in student attitude toward vocational education by videotape and film presentations*. Palo Alto, California: American Institute for Research in the Behavioral Sciences, 1970. (ERIC Document Reproduction Service No. ED 043 778)

Garry, R. J. *Report of research on the integration of science teaching by television into the elementary school program*. Boston, Massachusetts: Boston University, 1960, 79 p. (USOE Project No. 031; University Microfilms Pub. No. 61-3616)

Goldman, B. A. *Effect of classroom experience and video tape self-observation upon undergraduate attitudes toward self and toward teaching*. Washington, D.C.: American Psychological Association, 1969.

Goodson, C. M. *A study of the effectiveness of computer assisted instruction as compared to traditional instruction when utilized in technical mathematics for college students in business and engineering technology*. Houston, Texas: University of Houston, 1975.

Greenberg, B. S. "Operation abolition" vs. "operation correction." *AV Communication Review*, 1963, *11*, (3), 40-46.

Greenhill, L. P. Application of sound motion pictures to research in clinical psychology. *AV Communication Review*, 1957, *5*, 528-539.

Greenhill, L. P., Carpenter, C. R., & Ray, W.S. Further studies of the use of TV. *AV Communication Review*, 1956, *4*, 200-215.

Greenhill, L. & McNiven, M. Relationship between learning and the perceived usefulness of a film. *AV Communication Review*, 1956, *4*, 255-265.

Hall, K. A., et.al. *Inservice mathematics education for elementary school teachers via computer-assisted instruction*. University Park, Pa.: The Pennsylvania State University, 1969. (ERIC Document Reproduction Service No. ED 076 043)

Hanson, M. L. *Effectiveness of film in changing parental attitudes*. Salt Lake City, Utah: Utah University, 1968. (ERIC Document Reproduction Service No. 020 659)

Hayes, R. B. Immediate learning reinforcement. *AV Communication Review*, 1966, *14*, 377-381.

Hempstead, J. *Media and the learner: the influence of media-message components on students' recall and attitudes toward the learning experience*. University of Wisconsin, 1973.

Hess, R. D. & Tenezakis, M. D. Selected findings from "The computer as a socializing agent: some socioaffective outcomes of CAI." *AV Communication Review*, 1973, *21*, 311-325.

Holmes, P. D., Jr. *Television research in the teaching-learning process*. Unpublished doctoral dissertation, Wayne State University, 1959.

Hunt, L. C., Jr. *An experimental project appraising the effectiveness of a program series on reading instruction using open-circuit television.* The Pennsylvania State University: The Reading Center of the College of Education, March 1961.

Instructional Film Research Program. *Evaluation of film: Military police support in emergencies (riot control)* (TF 19-1701). Port Washington, L. I., New York: Pennsylvania State University for the Special Devices Center, Office of Naval Research, October 28, 1954.

Jacobs, J. N. & Bollenbacher, J. K. Teaching 9th grade biology by television. *AV Communication Review*, 1960, *8*, 176-191.

Janes, R. W. Preexisting attitudes of college students to instructional television. *AV Communication Review*, 1964, *12*, 325-335.

Janis, I. L. & Feshbach, S. Effects of fear-arousing communications. *Journal of Abnormal and Social Psychology*, 1953, *48*, 78-92.

Jouko, K. *The effect of directive teaching materials on the affective learning of pupils*. Jyvaskyla, Finland: Institute for Educational Research, Report Number 139, 1972.

Katzman, N. & Nyenhuis, J. Color vs. black-and-white effects on learning, opinion, and attention. *AV Communication Review*, 1972, *20*, 16-28.

Keating, J. P. & Latane, B. Distorted television reception, distraction, and attitude change. *Proceedings of the 80th Annual Convention of the American Psychological Association*, 1972, *7*, 141-142.

Kihava, K., Hatta, S., Tanaka, K., & Maeda, T. An analysis of teaching science through television in school. *Bulletin of the Faculty of Education* (printed in Japanese). Nagoya, Japan: University of Nagoya, 1961, *8*, 225-272.

Kishler, J. P. *The effects of prestige and identification factors on attitude restructuring and learning from sound films*. University Park, Pa.: The Pennsylvania State University, 1950. (ERIC Document Reproduction Service No. ED 053 568)

Klapper, H. L. *Closed-circuit television as a medium of instruction at New York University, 1956-1957* (A Report on New York University's Second Year of Experimentation with Television in College Classrooms). New York University, 1958.

Knowlton, J. & Hawes, E. Attitude: Helpful predictor of audiovisual usage? *AV Communication Review*, 1962, *10*, 147-157.

Kolmos, A. S. Effects of instructional media in teaching beginning statistics (Doctoral dissertation, University of Illinois, 1970). *Dissertation Abstracts International*, 1970, *31*, 4600A.

Kraemer, A. J., Bercini, D. H., & Harris, J. D. *Vicarious attitude change and the design of message films: application to race relation* (Hum RRO Tech. Rep. 75-8). Alexandria, Va.: Human Resources Research Organization, June, 1975.

Kraus, S. Modifying prejudice: attitude change as a function of the race of the communicator. *AV Communication Review*, 1962, *10*, 14-22.

Kumata, H. *Attitude change and learning as a function of prestige of instructor and mode of presentation*. East Lansing, Michigan: Communications Research Center, Michigan State University, 1958.

Lahey, G. F., et.al. *Use of an interactive general-purpose computer terminal to simulate training equipment operation*. San Diego, California: Navy Personnel Research and Development Center, November, 1975.

Lange, C. J., Rittenhouse, C. H., and Atkinson, R. C. *Films and group discussions as a means of training leaders* (Hum RRO Tech. Rep. 27). Fort Ord, California: Human Research Unit Nr 2, CONRAC, March, 1956.

Larimer, C. S. & Sinclair, W. W. Some effects of two-way television on social interaction. *AV Communication Review*, 1969, *17*, 52-62.

Levine, M. P. A comparative study of the achievement and attitudes of non-science oriented community college students instructed by closed-circuit television and lecture (Doctoral dissertation, New York University, 1973). *Dissertation Abstracts International*, 1973, *34*, 4027.

Levonian, E. Development of an audience-tailored film. *AV Communication Review*, 1960, *8*, 62-68.

Levonian, E. The use of film in opinion measurement. *AV Communication Review*, 1962, *10*, 250-254.

Levonian, E. Opinion change as mediated by an audience-tailored film. *AV Communication Review*, 1963, *11*, 104-113.

Lisson, H. E. The effects of variations in response modes and media on performance time and attitudes (Doctoral dissertation, University of Rochester, 1970). *Dissertation Abstracts International*, 1970, *31*, 3343A-3344A.

Litcher, J. H. & Johnson, D. W. Changes in attitudes toward negroes of white elementary school students after use of multi-ethnic readers. *Journal of Educational Psychology*, 1969, *60*, 148-151.

Livingston, S. A. *Simulation games and attitudes toward the poor: Three questionnaire studies*. Baltimore, Maryland: Johns Hopkins University, 1971.

Lottes, J. T., Jr. The effects of open-circuit television demonstrations of reading instruction on the observed classroom performances and attitudes of teachers (Doctoral dissertation, Pennsylvania State University, 1960). *Dissertation Abstracts*, 1960, *21*, 2633.

MacLean, M. S., Jr. & Toch, H. H. The group interview as an audience reaction measure. *AV Communication Review*, 1959, *7*, 209-219.

Macomber, F. G., Siegel, L., Hathaway, S. C., & Dome, J. E. *Experimental study in instructional procedures* (Report No. 2). Oxford, Ohio: Miami University, October 1, 1957.

Marshall, C. & Maguire, T. The computer as social pressure to produce conformity in a simple perceptual task. *AV Communication Review*, 1971, *19*, 19-28.

McFarlane, A. M. A study of the influence of an educational geographical film on the racial attitudes of a group of elementary school students. *British Journal of Educational Psychology*, 1945, *15*, 152-153.

Menzies, E. S. The effects of repeated exposure to televised violence upon attitudes toward violence among youthful offenders (Doctoral dissertation, Florida State University, 1973). *Dissertation Abstracts International*, 1973, *33*, 3025A.

Merrill, I. R. Liking and learning from educational television. *AV Communication Review*, 1956, *4*, 233-245.

Merrill, I. R. Attitude films and attitude change. *AV Communication Review*, 1962, *10*, 3-13.

Merrill, I. R. & McAshan, H. H. Predicting learning, attitude shift, and skill improvement from a traffic safety film. *AV Communication Review*, 1960, *8*, 263-274.

Meyer, V. H. & Gute, J. *The effects of channel variation on attitude change and source credibility*. Paper presented at the Western Speech Communication Association Convention, Honolulu, 1972. (ERIC Document Reproduction Service No. ED 071 112)

Miller, G. & Roberts, K. Communication race, open- and closed-mindedness, and response to informative communications. *AV Communication Review*, 1965, *13*, 259-269.

Miller, H. R. Sequencing and prior information in linear programmed instruction. *AV Communication Review*, 1969, *17*, 63-76.

Miller, W. C. *An experimental study of the relationships of film movement and emotional involvement response and its effect on learning and attitude formation*. Los Angeles: University of Southern California, 1967. (ERIC Document Reproduction Service No. ED 017 172)

Miller, W. C. Film movement and affective response and the effect on learning and attitude formation. *AV Communication Review*, 1969, *17*, 172-181.

Morrison, A. H. *An experimental study utilizing closed circuit television in the teaching of dental techniques*. New York: New York University, New York College of Dentistry, 1967.

Morin, A. F. Do educational films produced with same-race-communicators promote learning? *The Journal of Negro Education*, 1976, *45*, 197-203.

Neidt, C. O. *Changes in attitude during learning: The relationship of new educational media to non-intellective factors in learning--Phase II*. Fort Collins, Colorado: Colorado State University, December, 15, 1964.

Neidt, C. O. Use of videotaped instructional television for teaching study skills in a university setting. *AV Communication Review*, 1967, *15*, 269-284.

Neidt, C. O. & Sjogren, D. D. Changes in student attitudes during a course in relation to instructional media. *AV Communication Review*, 1968, *16*, 268-279.

Noall, M. F. & Winget, L. The physics film project. *Bulletin of the National Association of Secondary-School Principals*, 1959, *43*, 181-195.

O'Brien, S. J. The effect of television instruction on problem solving attitudes of fifth and sixth grade students (Doctoral dissertation, Oregon State University, 1973). *Dissertation Abstracts International*, 1973, *34*, 2277A.

Peterson, R. C. & Thurstone, L. L. *Motion pictures and the social attitudes of children*. New York: McMillan. 1933.

Piersma, M. L. Change in children's attitudes and stereotypes toward Africa after the use of three instructional approaches (Doctoral dissertation, University of South Dakota, 1974). *Dissertation Abstracts International*, 1974, *35*, 3400A-3401A.

Piper, M. & Butts, D. *The development and evaluation of a televised science inservice program*. Paper presented at the 47th annual convention of the National Association for Research in Science Teaching, Chicago, April 1974. (ERIC Document Reproduction Service No. ED 091 202)

Popham, W. J. *Tape recorded lectures in the college classroom II--an experimental appraisal*. San Francisco, California: San Francisco State College, August 1961.

Popham, W. J. Pictorial embellishments in a tape-slide presentation. *AV Communication Review*, 1969, *17*, 28-35.

Popham, W. J. & Sadnavitch, J. M. *The effectiveness of filmed science courses in public secondary schools*. Pittsburgh, Kansas: Department of Education and Psychology, Kansas State College, August, 1960.

Rawsey, R. E. *Audio-tutorial versus conventional lecture-laboratory instruction in a university animal biology course*. Paper presented at the Research and Technology in College and University Teaching National Conference, Second, Atlanta, Georgia, November, 1974.

Redemsky, L. W. Student evaluation of films used in college social studies. *AV Communication Review*, 1959, *7*, 3-13.

Reeser, G. W. The relative effectiveness of selected instructional media for stimulating student awareness of and interest in the construction industry (Doctoral dissertation, The Ohio State University, 1971). *Dissertation Abstracts International*, 1972, *33*, 1004A.

Reid, R. O. A comparison of a multi-image and linear film format as agents of attitude change (Doctoral dissertation, Syracuse University, 1970). *Dissertation Abstracts International*, 1970, *31*, 5675A.

Rizik, T. A. Psychometric assessment of the cognitive and affective impact of media. *British Journal of Educational Technology*, 1974, *5*, 19-30.

Rogers, R. W. *An analysis of fear appeals and attitude change*. Final report, 1973, University of South Carolina, Grant No. 1 R03 MH22157-01 MSM, National Institute of Mental Health.

Scanland, F. W. *An investigation of the relative effectiveness of two methods of instruction, including computer-assisted-instruction, as techniques for changing parental attitudes of negro adults*. Tallahassee, Florida: State University of Tallahassee, 1970. (ERIC Document Reproduction Service No. ED 043 224)

Schrucher, R. V. *Affective and cognitive gains made by students in an audio-tutorial world civilizations course compared with students enrolled in a traditionally taught world civilizations course*. Unpublished doctoral dissertation, Northeast Missouri State University, 1974.

Schwartz, S. Film music and attitude change (Doctoral dissertation, Syracuse University, 1970). *Dissertation Abstracts International*, 1970, *31*, 5677A.

Seiler, William. The effects of visual materials on attitudes, credibility and retention. *Speech Monographs*, 1971, *38*, 331-334.

Simonson, M. R. Attitude change and achievement: Dissonance theory in education. *Journal of Educational Research*, 1977, *70*(3), 163-169.

Sims, J. V. A comparative analysis of attitudes of students taught introductory college geography by closed circuit television and the classroom discussion method (Doctoral dissertation, University of Oklahoma, 1968). *Dissertation Abstracts*, 1968, *29*, 3347A.

Skinner, R., Jr. An experimental study of the effects of different combinations of television presentations and classroom teacher follow-up on the achievement and interest in science of fifth graders (Doctoral dissertation, Kent State University, 1966). *Dissertation Abstracts*, 1967, *28*, 551A.

Smith, E. P. The effects of a filmstrip/tape program on teachers' attitudes toward behaviorally stated objectives. *AV Communication Review*, 1972, *20*, 443-457.

Smith, P. D. Teaching sociology by film. Teaching Sociology, 1973, 1(1), 48-61.

Souers, C. V. Incidental treatment effects on students' attitudes toward a current social problem (Doctoral dissertation, Indiana University, 1973). Dissertation Abstracts International, 1973, 33, 4955A.

Spigle, I. S. The cumulative effect of selected educational motion pictures on the attitudes of high-school boys and the relationship of attitude changes to selected personality and intelligence factors. Unpublished doctoral dissertation, School of Education, Indiana University.

Sullivan, H. J. The effects of selected film and counseling experiences on capable girls' attitudes toward college. Monmouth, Oregon: Teaching Research Division, Oregon State System of Higher Education, September 30, 1964.

Tannebaum, P. H. Music background in the judgment of stage and TV drama. AV Communication Review, 1956, 4, 92-101.

Thomas, W. I. & Znaniecki, F. The Polish Peasant in Europe and America. Boston: Badger, 1918.

Thurstone, L. L. Influence of motion pictures on children's attitudes. Journal of Social Psychology, 1931, 2, 232-234.

Tobias, S. Lack of knowledge and fear of automation as factors in teachers' attitudes toward programmed instruction and other media. AV Communication Review, 1966, 14, 99-109.

Tobias, S. Effects of attitudes to programmed instruction and other media on achievement from programmed materials. AV Communication Review, 1969, 17, 299-306.

Toch, H. H. Prejudgments of educational television: A study of stereotypes. AV Communication Review, 1960, 8, 50-61.

VanderMeer, A. W. Ten recent Title VII reports: A perspective. AV Communication Review, 1961, 9, 35-44.

Vickers, N. L. An analysis of three methods of teaching English on the attitude and achievement of emotionally deprived children (Doctoral dissertation, Mississippi State University, 1972). Dissertation Abstracts International, 1972, 33, 1425A.

Wall, V., Jr. & Boyd, J. Channel variation and attitude change. Journal of Communication, 1971, 21, 363-367.

Walton, N. R. A pilot study of student attitudes in a closed circuit television course by use of stimulated recall (Doctoral dissertation, Michigan State University, 1963). Dissertation Abstracts, 1963, 24, 1082.

Watts, P. R. Comparison of knowledge gain and attitude change among three methods of teaching sex education to university personnel health classes (Doctoral dissertation, Indiana University, 1974). *Dissertation Abstracts International*, 1974, *35*, 2558A.

Weisgerber, R. A. *The effects of science motivational films on the attitudes of secondary school pupils toward the field of science*. Bloomington, Indiana: Indiana University, 1960.

Weisgerber, R. A. & Coles, G. J. *Evaluating the potential of films for improving self-image in minority group children*. Washington, D.C.: National Center for Educational Research and Development, 1971. (ERIC Document Reproduction Service No. ED 061 726)

Weldon, E. S., Jr. Effects of a television course on attitudes of a selected group of teachers (Doctoral dissertation, University of Florida, 1962). *Dissertation Abstracts*, 1962, *23*, 2762.

Welliver, P. W. Television instruction and the attainment of objectives for a ninth grade physical science course. *Journal of Research in Science Teaching*, 1967, *5*, 81-88.

Westley, B. H. & Jacobson, H. K. Dimensions of teachers' attitudes toward instructional television. *AV Communication Review*, 1962, *10*, 179-185. (a)

Westley, B. H. & Jacobson, H. K. Teacher participation and attitudes toward instructional television. *AV Communication Review*, 1962, *10*, 328-333. (b)

Westley, B. H. & Jacobson, H. K. Instructional TV and student attitudes toward teacher, course, and medium. *AV Communication Review*, 1963, *11*, 47-60.

Wickline, L. E. The effect of motivational films on the attitudes and understandings of high school students concerning science and scientists (Doctoral dissertation, Pennsylvania State University, 1964). *Dissertation Abstracts*, 1965, *26*, 915.

Wilkinson, G. G. The effect of supplementary materials upon academic achievement in and attitude toward mathematics among eighth grade students (Doctoral dissertation, North Texas State University, 1971). *Dissertation Abstracts International*, 1971, *32*, 1994A.

Wilson, M. K. *A study of college administrator attitude development through a simulation game*. University of Alabama, 1974.

Winick, C. Tendency systems and the effects of a movie dealing with a social problem. *Journal of General Psychology*, 1963, *65*, 289-305.

Winn, W. & Everett, R. *Differences in the affective meaning of color and black and white pictures*. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, 1978.

Wittich, W. A, Pella, M. O., & Wedemeyer, C. A. The Wisconsin physics film evaluation project. Madison, Wisconsin: University of Wisconsin, 1959.

Woodward, J. C. Attitude and achievement comparisons for direct and television classes in biological science (Report 3). Coral Gables, Florida: Office for the Study of Instruction, University of Miami, June 1964.

Woodward, J. C. Attitude and achievement comparisons for direct and television classes in biological science. Coral Gables, Florida: Miami University and Florida University College, 1964. (ERIC Document Reproduction Service No. ED 044 936)

Wright, J. H. The effect of television-oriented inservice programs on the elementary teacher's attitude toward some components of environmental education (Doctoral dissertation, University of Denver, 1971). Dissertation Abstracts International, 1971, 32, 5662A.

Zimbardo, P. & Ebbesen, E. Influencing attitudes and changing behavior. Reading, Massachusetts: Addison-Wesley, 1970.

TITLE: Relating What is to be Learned to What is
Known: Subsumptive Sequencing,
Co-ordination, and Cognitive Skills Activation

AUTHORS: Faith S. Stein

Jody K. Witham

Charles M. Reigeluth

RELATING WHAT IS TO BE LEARNED TO WHAT IS KNOWN:
SUBSUMPTIVE SEQUENCING, CO-ORDINATION, AND COGNITIVE SKILLS ACTIVATION

By

Faith S. Stein

Jody K. Witham

Charles M. Reigeluth

IDD&E Working Paper No. 2

March 1980

Instructional Design, Development, and Evaluation
School of Education, Syracuse University

Relating What is to be Learned to What is Known: Subsumptive Sequencing, Co-ordination, and Cognitive Skills Activation

One of the most important functions of instruction is to assist learners in relating new content to existing cognitive structures. Ausubel's development of the advance organizer was an attempt to serve this function, but the approach has not been widely adopted for a variety of reasons, including a lack of specificity about different ways in which such relationships can be made or facilitated. This paper reports on some recent advances in the detailed specification of three different ways of effecting relationships between what is to be learned and what has already been assimilated within cognitive structure. These three methods are the use of subsumptive sequencing of instructional content, the use of coordinate linkages between content constructs, and instruction in and activation of appropriate generic or cognitive skills for manipulating and processing unfamiliar content (see Figure 1).

Insert Figure 1 about here.

Ausubel's work on the nature of meaningful learning emphasizes the centricity of the learner's cognitive structure in the acquisition of skills and knowledge (Ausubel, 1964; 1967). The act of "making meaningful" requires both the potential for relatability in the content to be learned and the potential for relating that content within the learner. Meaningful learning is a constructive process, in which linkages between external and internal content structures must be carefully and consciously built by the learner (see Figure 2). The conscious nature of this process requires an intent on the learner's part to make relationships and connections; as previously stated, that intent is delimited by the quality, quantity, and stability of the constructs and links already present within cognitive structure.

Insert Figure 2 about here.

Ausubel has suggested the use of advance organizers, which are general constructs of greater abstractness and inclusiveness than the constructs to be assimilated; he maintains that introductory use of such content provides ideational anchorage for the constructs to be learned. However, the advance organizer has come under fire as being difficult to operationalize and research results are often non-replicable. What appears to be needed is a more precise means of analyzing the types of relationships that can and do exist among constructs in a subject area and a more precise set of strategies for assisting learners in perceiving and using those relationships as strategies for learning. Thus, the call is for a greater variety of well-defined strategies to aid in the process of meaningful learning.

What we wish to discuss today is not new or different from the lines of research and theory-building that have characterized cognitive psychology over the past several decades. Rather, we offer a reanalysis and synthesis of several lines of work on models of instruction and a set of prescriptions for the organization of instruction that take into account the relationships among content in a subject area. We can begin with a brief description of the lexicon in which these relationships and strategies will be described.

Merrill's (Merrill and Wood, 1974) work on a taxonomy of instructional variables has delineated two major kinds of instructional elements: an _instance_, a specific object or event (or its representation) which exists or could exist in the real world; and a _generality_, a statement of a definitional or propositional relationship which can be applied to more than one object or event (i.e., instance). For example, the concepts "literature", "poetry", and "sonnet" are all generalities, while "Shall I Compare Thee To a Summer's Day" is an instance of all three generalities. On the basis of analysis of the type of operation involved in deriving the element (identity, descriptive, or productive) and the meaningful or rote nature of the operation, Merrill (Reigeluth, Merrill, and Bunderson, 1978) has identified five major types of subject matter content or constructs: facts, subsets, concepts, procedures, and principles.

Moreover, with the exception of facts, each of the content types can be manipulated at three different task levels: remember, use, and find. For example, one can remember the definition of a concept (the set of critical attributes) or an familiar instance of that concept, or one can use the definition to classify unfamiliar instances, or, given a set of instances, one can identify and use the common attributes to form a concept definition which characterizes their identity as a set (see Figure 3.).

Insert Figure 3 about here.

Accordingly, considerations of content element, content type, and task level can be used to characterize subject matter constructs individually and in relationship to each other. Analyses of the individual constructs and their relationships to each other lead to prescription of instructional strategies that are specific to the type of construct or relationship that must be acquired by the learner. Moreover, it is our hypothesis that learning increases to the extent that learners are helped to understand not only that constructs in a content area are related, but also how they are related. Relationships between familiar and unfamiliar content can be identified as being one of two major types ---hierarchical or coordinate. Each type can take several forms (see Figure 4).

Insert Figure 4 about here.

RELATIONSHIPS

Hierarchical Relationships. Hierarchical relationships exist between generalities and their instances and among generalities.

Generalities and Their Instances. A generality --- a concept, procedure, or principle--- explains, classifies, or relates groups of natural phenomena. Generalities are hypothetical, even though their expression may have acquired the status of convention or standard among large groups of people. The instances of a generality have existence in the real world and function to make the generality meaningful. Thus, a child learns the generality "hot" by touching things (instances) of varying degrees of warmth and associating the sensation of each with the concept. The instances become associated with the concept and the concept with the instances. In order to be able to use the concept to classify new instances, the child must encounter many different instances which exhibit differing values of the attribute "temperature" and must learn to judge which of those instances fall within the parameters defining membership in the "hot" class. Thus, the generality becomes meaningful and usable only through multiple instantiation.

Generalities and Generalities. Hierarchical relationships also exist among generalities. The most broadly applicable of these hierarchical relationships is the taxonomy. In taxonomic relationships, higher-order generalities subsume lower-order generalities, which in turn subsume even lower-order generalities. For example, "literature" subsumes "poetry" which in turn subsumes "sonnet". At the apex of the taxonomy is the most general, abstract, and inclusive generality; at progressively lower levels, the generalities become more specific, concrete, and limited. Equally, the set of acceptable instances becomes smaller at each lower level of the taxonomy. The set of instances for the generality "vertebrate" is much larger, and has broader critical attributes, than the set of instances for the generality "dog", which in turn is larger than the set for the generality "spaniel".

The taxonomic structure utilizes two kinds of relationships among generalities; one generality may be a _part_ or a _kind_ of another higher-order generality. For example, we can talk about the parts of a poem (stanzas, lines, imagery, and theme) or the kinds of poems (sonnets, odes, ballads, or limmericks).

Each type of generalizable content can be represented in parts or kinds taxonomies. Principles are composed of parts which are concepts; several different kinds of more specific and concrete principles may be subsumed under a highly abstract, general principle. Higher-order concepts are defined in terms of attributes which are themselves lower-order concepts; also, lower-order concepts are parts or kinds of higher-order ones. And general procedures subsume more specific lower-order procedures and are composed of parts or steps (see Figure 5).

The structure of content in a subject matter area can thus be analyzed into the kinds of relational components ---the kinds of content--- and the nature of relationships among those components. Both the individual constructs and their relationships can and should be taught.

Insert Figure 5 about here.

Co-ordinate Relationships. Co-ordinate relationships among instances and among generalities are another important and useful type of connection. Co-ordinate relationships can be made in three ways.

Co-ordination among Instances. Instances of the same generality have co-ordinate relationships whose emphasis during instruction can enhance learning of the generality. Even while they share a common set of attributes, instances differ from each other in two ways, first in the levels or values of their shared attributes (for concepts) or the appropriate contexts for application (for procedures or principles) and second in non-shared but distracting components of attributes or contexts. Identification and use of similarities and differences among instances of a generality assists learners in increasing their ability to generalize beyond the instances provided during the instruction (see Figure 6).

Insert Figure 6 about here.

Co-ordination among Generalities. Generalities have co-ordinate relationships with each other, as parts or kinds of higher-order, subsuming generalities. Fitting a new generality within the learner's existing knowledge involves linking it both hierarchically and laterally to already familiar constructs. For example, the three kinds of sonnets ---Shakespearean, Petrarchan, and Spenserian--- are kinds-coordinates under the more general concept "sonnet". The more familiar Shakespearean can be used to anchor the other two less familiar kinds through comparison and contrast. The more links and the more kinds of links among generalities a learner is able to make, the more firmly the new construct will be anchored and retained. At the same time, generalities must be demonstrably separate from each other or obliterative subsumption (Ausubel, 1967) will occur. The instructional identification of co-ordinate linkages ---similarities and differences--- among generalities at the same taxonomic level may help to prevent obliterative subsumption (see Figure 7).

Insert Figure 7 about here.

Analogic Relationships. The preceeding discussion has focused on types of relationships among constructs within a single subject-matter area. However, subject-matter areas can and should be related to one another, by means of analogy and metaphor. Such analogic statements create co-ordinate linkages among generalities of different areas; they can be useful whenever the constructs to be taught are so new and unfamiliar to learners that no subsuming or co-ordinate constructs are available from the learner's prior knowledge and experiences within the subject matter area to be learned to provide ideational anchorage. An analogy creates co-ordination between two normally very dissimilar constructs; it is useful for producing comparative transfer of crucial qualities from one construct to another. To help learners understand the dynamic nature of a city, a sociology professor can compare the city to a living organism; this analogy to a familiar biological construct can immediately and vividly articulate the crucial characteristics of a city in recognizable terms for learners (see Figure 8). It is a dramatic, cogent, and useful means of explication, and one which is too seldom used in instruction.

Insert Figure 8 about here

Activating Cognitive Skills. Equally important is the instructional identification of the kinds of relationships that exist among the various types of constructs. Instruction should make explicit the relationships among component concepts of a principle, defining how the concepts relate (as parts of the whole) and how the lower-order, more specific principles are special cases (kinds) of the higher-order case. Instruction should make explicit the relationships among attributes of a concept and how the lower-order concepts are parts (attributes) or kinds (special cases) of the higher-order case. And instruction should make explicit the relationships among the steps (parts) of a procedure and how the simpler, more specific lower-order procedures are special cases (kinds) of the higher-order one. Thus instruction should not only identify and use hierarchical and co-ordinate relationships among constructs as the basis for organizing the instruction, but also make explicit what those types of relationships are which can exist among various types of constructs and how learners can use them to manipulate content on their own.

Therefore, one additional kind of linkage merits discussion. The analytic and constructive activities by which designers and teachers identify constructs and relationships can be considered as constituting another kind of subject-matter area of equal importance in school learning. Generic or cognitive skills, such as definition, description, taxonomizing, and metaphor-making, represent a critical kind of knowledge which must also be meaningfully acquired during schooling. If we consider these skills as constituting a separate subject-matter area, we can see that they exist as generalities for which instances can be identified, that they can be used at all three task levels (remember, use, and find), and that they consist of all five types of constructs (facts, subsets, concepts, procedures, and principles). Thus, hierarchical and lateral relationships among these skills can be identified and used for instruction in these skills . Equally important, these skills, once acquired, can be activated as another means of clarifying constructs in any subject-matter area. A construct in an area such as biology can be made meaningful for learners by instructional methods which explicitly identify the construct as an instance of the skill-generality. Thus, a taxonomy of plants can be taught both as a set of biological constructs and as an example of taxonomizing. Explication of both the biological construct and the skill construct increases the types of ideational anchorage available for the plant taxonomy. A model airplane and a blueprint of a house can instantiate the concept "model"; the skill of model-building can be activated to help make meaningful the nature of an instructional model (see Figure 9). Thus, the activation of familiar cognitive skills and the identification of specific constructs (from the desired subject area) as instances of the use of those skills enhances the learning of the desired subject matter area.

Insert Figure 9 about here.

STRATEGIES

The identification and use of hierarchical and co-ordinate relationships among constructs is an important strategy for designing instruction. Specific organizational strategies can be specified for using each type of relationship to facilitate meaningful learning.

Strategies for Emphasizing Hierarchical Relationships.

To teach an individual construct, the primary strategy is instantiation. A generality is meaningful acquired to the extent that it is tied to referrents in the real world. Instances should be selected to meet the following criteria. First, a large enough set of instances should be selected to represent a sampling of the range of types of possible instances. The instances should be divergent (demonstrably different) on several nonrelevant components. The set should be sufficiently large to permit slow learners to acquire the construct. The set should represent a range of levels of difficulty, from very easy to very difficult. The set should include both familiar and unfamiliar instances.

Finally, instruction should continue on any one generality until the learner is able to generalize to the range of possible instances beyond those provided for instruction.

Component Display Theory (Merrill, in press) contains a set of strategy prescriptions for utilizing instances. Included are strategies for selecting and sequencing instances across a range of difficulty levels, for utilizing instances which are divergent on noncritical attributes, and for matching instances with noninstances.

To teach a set of related constructs, the primary strategy is elaboration. A set of generalities is more effectively learned to the extent that the relationships among the members of the set are explicated and used as learning strategies. The most superordinate constructs should be taught first, and linked to constructs already familiar to learners. Then the set of generalities which represent parts or kinds of that superordinate generality should be taught next. Each second-level generality should be taught explicitly in terms of its relationship to the subsuming generality. Each should be instantiated separately. Third, the next level of elaboration should present generalities which are parts or kinds of each separate second-level generality; again, the parts or kinds relationship for each hierarchical link should be made explicit and instantiation should occur for each generality separately. This progressively elaborated organizational structure should constitute the basic form of the instuction and should continue until all generalities have been taught in terms of their hierarchical relationships to each other.

The Elaboration Theory (Reigeluth, 1979) prescribes strategies for utilizing an elaborated hierarchy of subject matter constructs. Included are strategies for identifying key constructs to be taught and their orientation (conceptual, procedural, or theoretical), for constructing a hierarchy of content within that orientation, for presenting that hierarchy in terms of a series of levels of increasing detail and specificity, and for synthesizing and summarizing each level of the elaborated structure before proceding with next level (see Figure 10).

Insert Figure 10 about here.

Strategies for Emphasizing Co-ordinate Relationships.

In instruction on a single generality, the primary strategy is comparison and contrast among instances. Instances should be presented in terms of their shared critical attributes as well as in terms of non-shared attributes or irrelevant components. The set of instances should represent the range of acceptable values on critical components, while being as divergent as possible on non-critical components. Practice in distinguishing between acceptable and nonacceptable instances should also be provided.

Component Display Theory (Merrill, in press) prescribes the use of matched noninstances and divergence to faciliatate meaningful acquisition of the generality and to prevent application errors.

For instruction on a set of related generalities, the principal strategy is _synthesis_ at the conclusion of instruction at each level of elaboration. The set of generalities constituting a particular level should be presented in terms of their relationships to each other (co-ordinate kinds or parts) and those characteristics distinguishing one generality from another explicated. At this stage, an expanded taxonomy containing both hierarchical and co-ordinate linkages should also be a topic of instruction. Learners must be able to reinforce or correct their understanding of how generalities relate to each other as well as to their instances and to other generalities with which they were previously familiar. Instruction at the next level of elaboration should not begin until learners can demonstrate their understanding of relationships at that particular level (see Figure 11).

Insert Figure 11 about here

The Elaboration Theory (Reigeluth, 1979) calls for presenting (1) a simplified version of the synthesizer for a lesson _before_ the lesson, and (2) a complete version of the synthesizer for a lesson _after_ the lesson.

Strategies for Relating Extremely Unfamiliar Content.

Occasionally, the content to be learned may be so novel or unfamiliar to learners that no subsuming or coordinating construct within that subject matter area is available in the learners' cognitive structure to anchor the new knowledge. In such cases, the principal strategy is the use of *analogy and metaphor* by which a construct in some *other* subject area serves to familiarize the construct of interest. An analogy or metaphor serves as a "far" coordinate link between the constructs of interest and some other subject area through a *kinds* relationship. The familiar construct and the new construct are presented as sharing certain *characteristics* which are familiar to the learner. The learners' knowledge of the shared characteristics is used to familiarize the new construct so that the new construct can be meaningfully placed within the construct hierarchy in the subject area of interest. Thus, the analogy or metaphor is utilized to explicate the salient characteristics of the new construct so that the new construct becomes meaningful (see Figure 12).

Insert Figure 12 about here.

Strategies for Emphasizing the Structure of the Content. Concommitant with instruction on the constructs of interest in a particular subject matter area, there should also occur instruction in the nature of the structure of that area and in skills for deciphering and using that structure. Once generic cognitive skills have been acquired, learners should be directed by the instruction to activate those skills in order to examine how constructs relate to one another and in order to continue identifying and using those relationships on their own. Cognitive skills should be practiced, using the subject area of interest as instance pool. Instruction should emphasize how to analyze, or define, or construct analogies, as well as how to use the fruits of such activities performed by designers and teachers. Instruction should have dual goals of competence in a particular content area and competence in critical thinking and problem-solving.

The primary strategy for emphasizing acquisition of relationships is activation of previously learned cognitive skills and instruction, as needed, in new skills (see Figure 13). Several models of cognitive skills instruction exist; the reader is referred to Gagne and Briggs (1974) and O'Neill (1978) as examples.

Insert Figure 13 about here.

PROCEDURES

Procedures for Emphasizing Hierarchical Relationships

Procedures for Relating Generalities and their

Instances. Component Display Theory provides the model for structuring a lesson to teach a single construct (concept, procedure, or principle). Four prescriptions relate directly to the use of instances (see Figure 14). First, instances should be selected which represent a range of levels of difficulty; easy or familiar instances should be presented before unfamiliar or difficult ones. Moreover, both instructional instances and practice instances should appear in easy-to-difficult sequences.

Insert Figure 14 about here.

Second, the instances should be divergent with respect to noncritical components so that learners can be helped to avoid undergeneralizing or overgeneralizing the construct. For procedures and principles, contexts of instances should be varied on at least two dimensions; for concepts, noncritical attributes should vary on at least two dimensions.

Third, instances and feedback for instance practice should contain attribute isolation so that the salient characteristics of the instances are separated and emphasized for ease in perception. Algorithms and mnemonics should be used to assist learners in structuring their analysis and employment of instances.

Finally, instances should be presented for both instruction and practice in a variety of representational forms. Verbal, pictorial, and diagrammatic representation of instances provide learners with additional modes for relating instances to generalities since different representational forms cue different memorial structures and retrieval strategies (For a detailed sequence of procedures for implementing the strategy of instantiation, see Merrill, Reigeluth, and Faust, 1979).

Procedures for Relating Generalities. Elaboration Theory delineates a set of procedures for structuring instruction on a set of generalities. There are three basic strategies for developing an elaborated structure of content within a subject area (see Figure 14). First, an orientation structure must be selected that is congruent with the course goals and objectives. The orientation may be conceptual, procedural, or theoretical. Using that orientation, the constructs constituting the course are then delineated and intra-construct relationships are specified. The result of this effort is a taxonomy of the key constructs to be taught. Higher-order, more inclusive constructs occupy the top portion of the taxonomy and are used instructionally to anchor the lower-order, less inclusive constructs in the lower portions of the taxonomy through the process of subsumption. The orientation structure determines the kinds of strategies to be utilized in developing the elaborated structure.

Second, the epitome should be constructed. The epitome is a synthesizing set of constructs which summarize, at a very general level, the entire content structure to be taught. It portrays only the most important aspects of the orientation structure, and its related supporting structures. An epitome is like an overview, but it is derived from an orientation structure and is taught through the strategy of instantiation.

Third, the elaboration structure must be constructed in layers of increasing detail and complexity. The superordinate constructs are the most general and simple; each succeeding layer adds complexity and detail to ---elaborates on--- the layer before it. The complete elaboration structure contains all the subject matter constructs and their interrelationships in the area. Each level of elaboration is taught separately by developing parts or kinds relationships among its constructs and the superordinate constructs of the previous (higher) level, by identifying the parts-coordinate or kinds-coordinate relationships among the constructs within that level of elaboration, and by instantiating each construct individually (For more detailed information on the construction of elaborated content structures, see Reigeluth, Merrill, Wilson, and Spiller, in press; and Reigeluth and Rogers, 1980).

Procedures for Emphasizing Co-ordinate Relationships

Procedures for Relating Instances within a Single Generality. The procedure consists of three strategies (see Figure 14). First, matched instances and noninstances should be presented together during instruction so that learners can be made aware of the importance of attending to both critical and noncritical aspects of the instances. Second, alternative representations of instances should be used to assist learners in avoiding undergeneralizing to instances in different representational forms. Finally, instances which are divergent on several noncritical aspects should be utilized to help learners avoid undergeneralizing (For more detailed information on the selection and sequencing of instances, see Merrill, in press).

Procedures for Relating Generalities at the same Level of Elaboration. There are three strategy components in building instruction that elucidates co-ordinate relationships among generalities (see Figure 14). First, the type of relationship ---kinds or parts--- should be made overt and the attributes or elements which separate the different generalities should also be articulated. Thus, the higher-order construct should be used to anchor the various lower-order parts or kinds; then comparison and contrast among the lower-order constructs should be used to identify their uniquenesses and their co-ordinate relationships. Second, the instruction on each level of elaboration should commence and conclude with the relational structure, in the form of an *internal synthesizer* which articulates the parts or kinds relationships in advance of and after instruction on each separate generality within that level. Third, an *external synthesizer* should be provided at the conclusion of the entire layer of elaboration to relate that layer to the orientation structure as a whole. Thus, by building co-ordinate relationships within each level of elaboration and hierarchical relationships among levels of the elaboration, relationships among generalities are elucidated and taught.

Procedures For Relating Generalities Across Subject Matter Areas. The analogy provides the basis for the strategy for relating generalities from different subject matter areas (see Figure 14). The familiarizing analogue must already exist in cognitive structure, or be aquired prior to its use. There are three strategies involved in using analogies. First, the familiar analogue must be of the same content type (concept, principle, or procedure) and at the same level of generality and inclusiveness as the content it is intended to familiarize. Second, the critical attributes of the familiar analogue should be articulated and compared with the similar critical attributes of the new content. Third, the instruction must make the learner aware of the limitations of the analogy (aspects where the analogy breaks down). The analogy is most useful when it familiarizes several related constructs. Therefore, the instructional analogy (familiarizer) is a tool for providing ideational scaffolding for extremely unfamiliar content which has no within-subject-matter-area anchorage available.

Procedures for Activating Cognitive Skills. There are two methods for activating cognitive skills during instruction (see Figure 14). Instruction may either require the student to perform a given cognitive skill in order to produce a desired response or instruction may tell the learner to use a skill rather than produce an answer. Rigney (1978) refers to the former as an embedded strategy and the later as a detached strategy. To use an embedded strategy, the instruction should require the learner to perform in such a way that a previously aquired cognitive skill is required; requiring the learner to analyze a problem in order to determine the type of answer needed involves the embedded skill of analysis To use a detached strategy, instruction should suggest to the learner that a particular cognitive skill be utilized as a means of organizing, storing, or retrieving information; suggesting that the learner draw a picture of a construct to help him/her remember it better involves a detached cognitive strategy. Both embedded and detached strategies should be incorporated within instruction. Attention-focusing devices which isolate particular cognitive skills should be utilized to increase learner awareness of the usefulness of those skills in manipulating knowledge. The constructs within a particular subject area can provide an instance pool for teaching new cognitive skills. Once acquired, those skills should be overtly activated in instruction that encourages learners to apply the skills in manipulating content on their own.

Instruction should make overt those cognitive skills by which the content was prepared for the learners. Including references to particular skills during instruction will increase learners' facility with those skills as well as making learners more aware of how knowledge can be manipulated. Therefore, instruction in cognitive skills should accompany instruction in subject matter content.

REFERENCES

Ausubel, D.P. Some psychological aspects of the structure of knowledge. In S. Elam (Ed.), *Education and the Structure of Knowledge*. Chicago: Rand McNally, 1964.

Ausubel, D.P. A cognitive-structure theory of school learning. In L. Siegel (ed.), *Instruction: Some Contemporary Viewpoints*. San Francisco: Chandler Publishing Company, 1967.

Gagne, R.M. and Briggs, L.J. *Principles of Instructional Design*. New York: Holt, Rinehart and Winston, 1974.

Merrill, M.D. The Component Display Theory. In C.M.Reigeluth (Ed.), *Instructional Design Theories and Models: An Overview of their Current Status*, in press.

Merrill, M.D., Reigeluth, C.M., and Faust, G.W. The instructional quality profile: A curriculum evaluation and design tool. In H.F. O'Neill, Jr. (Ed.), *Procedures for Instructional Systems Development*. New York: Academic Press, 1979.

Merrill, M.D. and Wood, N.D. *Instructional Strategies: A Preliminary Taxonomy*. Columbus, Ohio: Ohio State University, 1974 (ERIC Document Reproduction Service No. SE 018 771).

O'Neill, H.F. Jr., (Ed.). *Learning Strategies*. New York: Academic Press, 1978.

Reigeluth, C.M. In search of a better way to organize instruction: the elaboration theory. Journal of Instructional Development, 1979, 2(3), 8-15.

Reigeluth, C.M., Merrill, M.D., and Bunderson, C.V. The structure of subject matter content and its instructional design implications. Instructional Science, 1978, 7, 107-126.

Reigeluth, C.M. and Rodgers, C.A. The elaboration theory of instruction: Prescriptions for task analysis and design. NSPI Journal, 1980, 19(1), 16-26.

Reigeluth, C.M., Merrill, M.D., Wilson, B.G., and Spiller, R.T. The Elaboration Theory of Instruction: A Model for Structuring Instruction, in press.

Rigney, J.W. Learning strategies: A theoretical perspective. In H.F. O'Neill (Ed.), Learning Strategies. New York: Academic Press, 1978.

RELATIONSHIP	STRATEGY
HIERARCHICAL - GENERALITY TO INSTANCE	INSTANTIATION
HIERARCHICAL - GENERALITY TO GENERALITY	ELABORATION
CO-ORDINATE - GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE	SYNTHESIS COMPARISON AND CONTRAST
ANALOGIC - GENERALITY TO GENERALITY	FAMILIARIZE
HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR	ACTIVATION OF COGNITIVE SKILLS

Figure 1. An Epitome

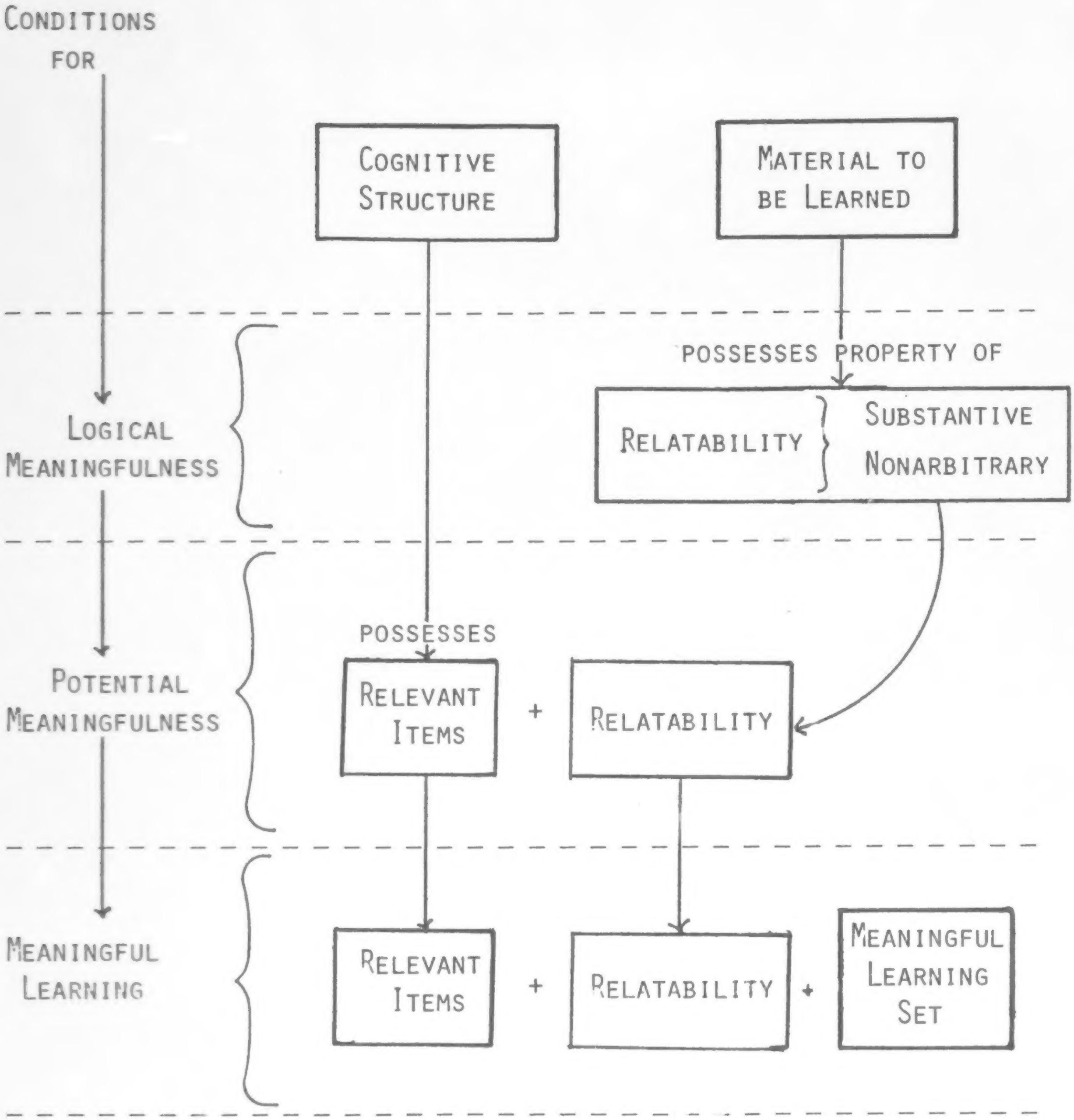

CONDITIONS FOR
COGNITIVE STRUCTURE
MATERIAL TO BE LEARNED
POSSESSES PROPERTY OF
LOGICAL MEANINGFULNESS
RELATABILITY
SUBSTANTIVE
NONARBITRARY
POSSESSES
POTENTIAL MEANINGFULNESS
RELEVANT ITEMS
+
RELATABILITY
MEANINGFUL LEARNING
RELEVANT ITEMS
+
RELATABILITY
+
MEANINGFUL LEARNING SET

Figure 2. Requirements for logical meaningfulness, potential meaningfulness, and meaningful learning. (Ausubel, 1968, p.55)

Meaningful		CONCEPT Find a generality Use a generality Remember a generality Remember an instance	PRINCIPLE Find a generality Use a generality Remember a generality Remember an instance
Rote	FACT Remember a fact	SUBSET Find a generality Use a generality Remember a generality Remember an instance	PROCEDURE Find a generality Use a generality Remember a generality Remember an instance
	Identity	Descriptive	Productive

Figure 3. The Content Matrix

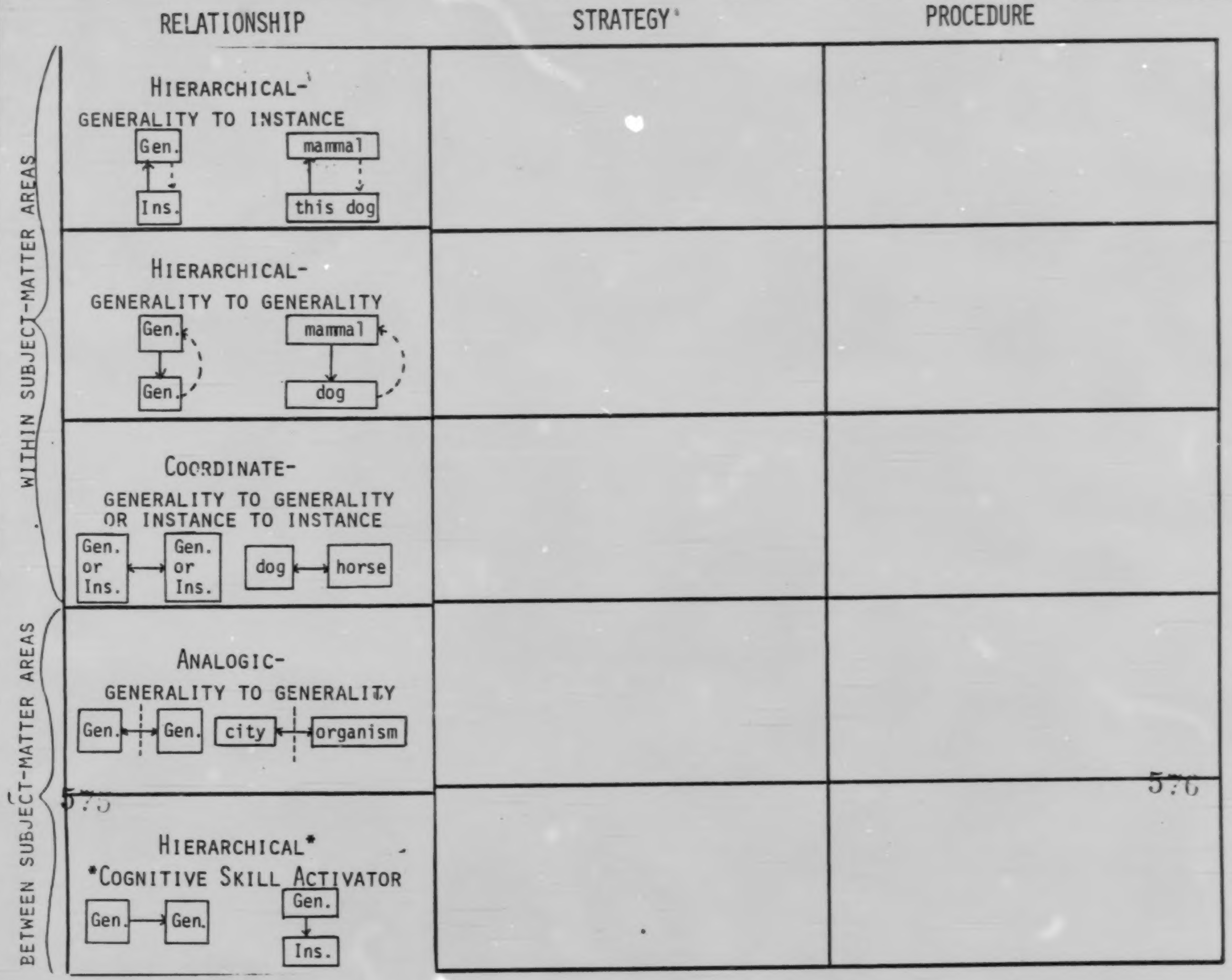
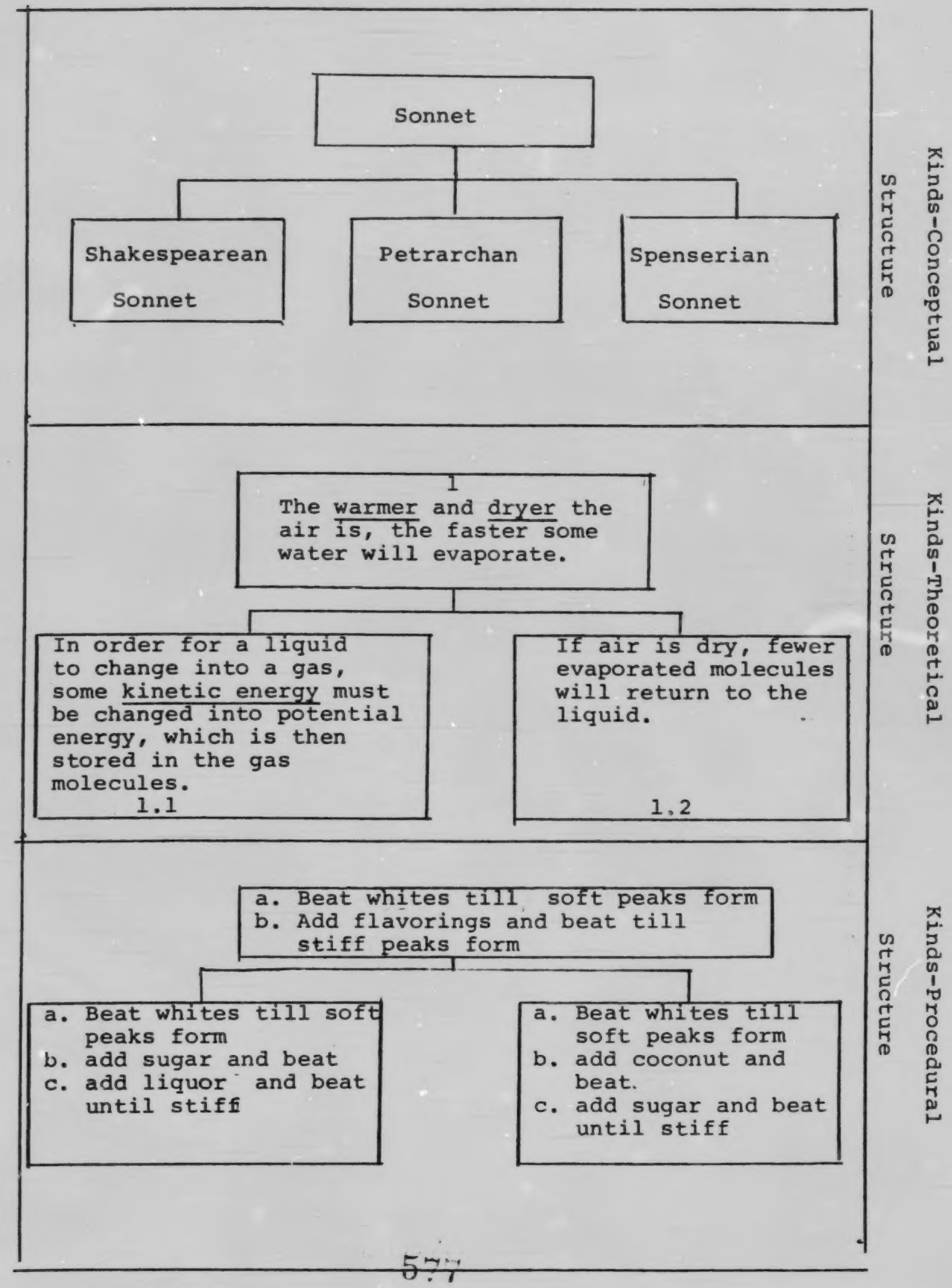

RELATIONSHIP
STRATEGY
PROCEDURE
WITHIN SUBJECT-MATTER AREAS
BETWEEN SUBJECT-MATTER AREAS
HIERARCHICAL-
GENERALITY TO INSTANCE
Gen.
Ins.
mammal
this dog
HIERARCHICAL-
GENERALITY TO GENERALITY
Gen.
Gen.
mammal
dog
COORDINATE-
GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE
Gen. or Ins.
Gen. or Ins.
dog
horse
ANALOGIC-
GENERALITY TO GENERALITY
Gen.
Gen.
city
organism
HIERARCHICAL*
*COGNITIVE SKILL ACTIVATOR
Gen.
Gen.
Gen.
Ins.

Figure 4. Types of Relationships

]



Kinds-Conceptual Structure
Kinds-Theoretical Structure
Kinds-Procedural Structure

Sonnet

Shakespearean Sonnet

Petrarchan Sonnet

Spenserian Sonnet

1 The warmer and dryer the air is, the faster some water will evaporate.

1.1 In order for a liquid to change into a gas, some kinetic energy must be changed into potential energy, which is then stored in the gas molecules.

1.2 If air is dry, fewer evaporated molecules will return to the liquid.

a. Beat whites till soft peaks form
b. Add flavorings and beat till stiff peaks form

a. Beat whites till soft peaks form
b. add sugar and beat
c. add liquor and beat until stiff

a. Beat whites till soft peaks form
b. add coconut and beat.
c. add sugar and beat until stiff

Figure 5. Hierarchical Structures Among Generalities

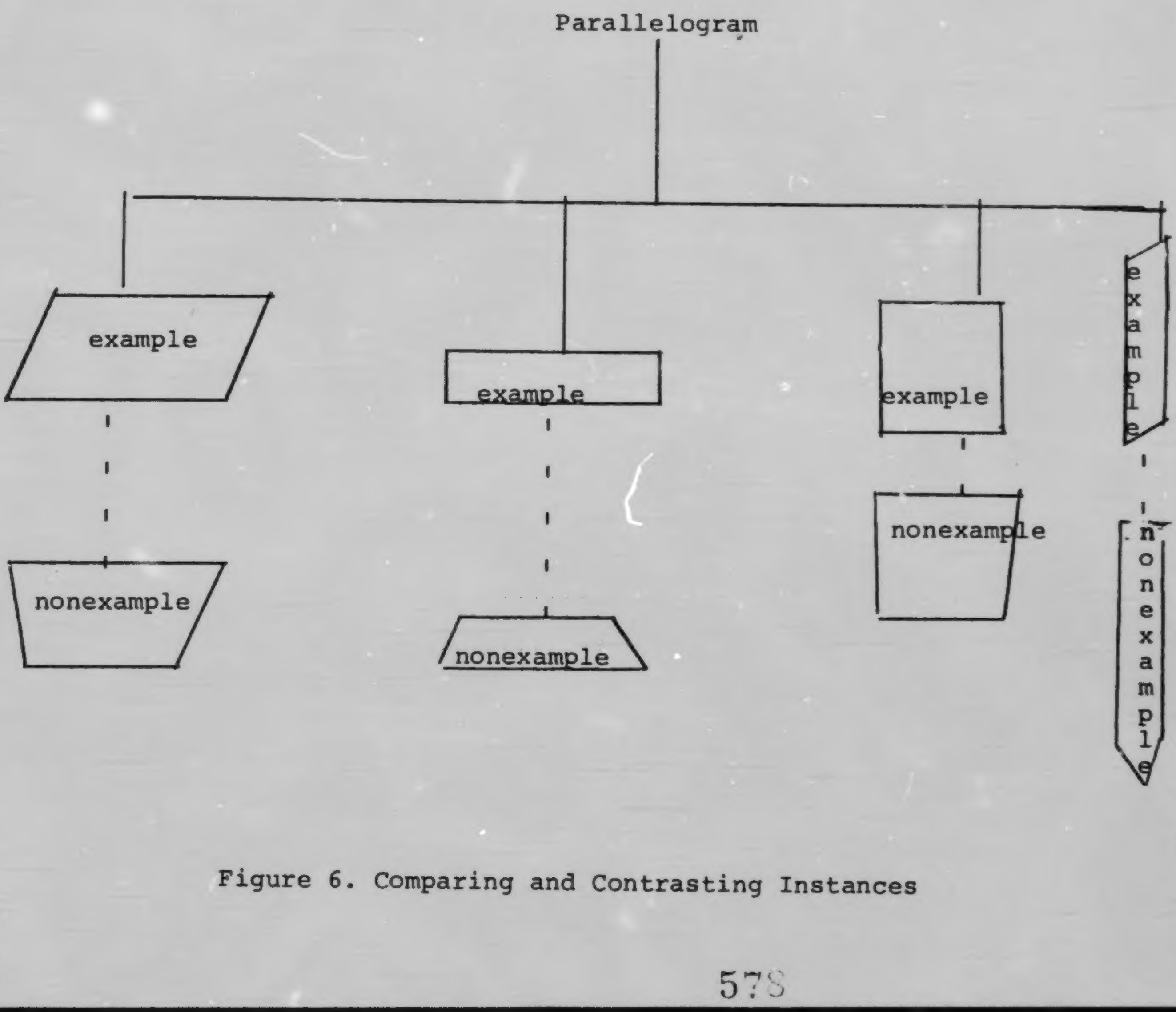

Parallelogram
example
nonexample
example
nonexample
example
nonexample
example
nonexample

Figure 6. Comparing and Contrasting Instances

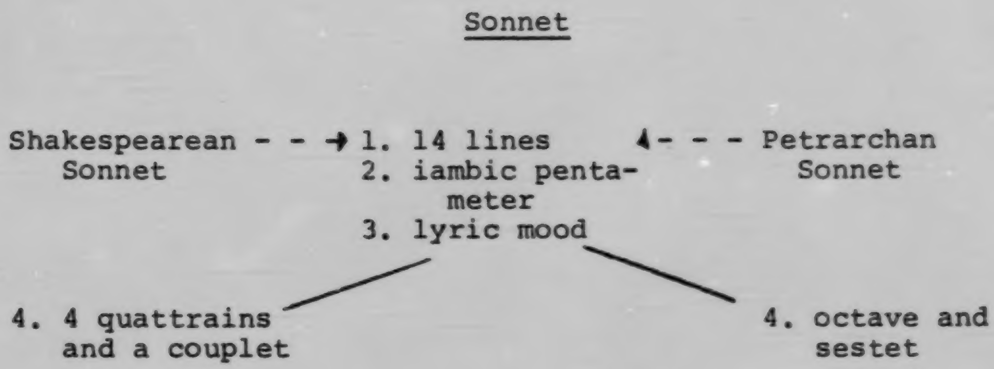

Sonnet
Shakespearean Sonnet
1. 14 lines
2. iambic pentameter
3. lyric mood
Petrarchan Sonnet
4. 4 quattrains and a couplet
4. octave and sestet

Figure 7. Comparing and contrasting co-ordinate generalities

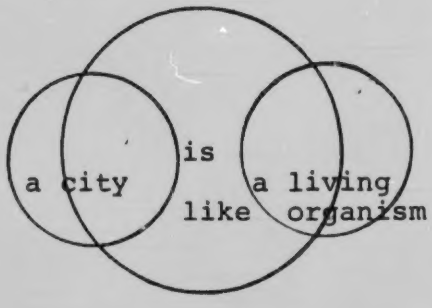

a city
is
like
a living
organism

Figure 8. Using analogic relationships

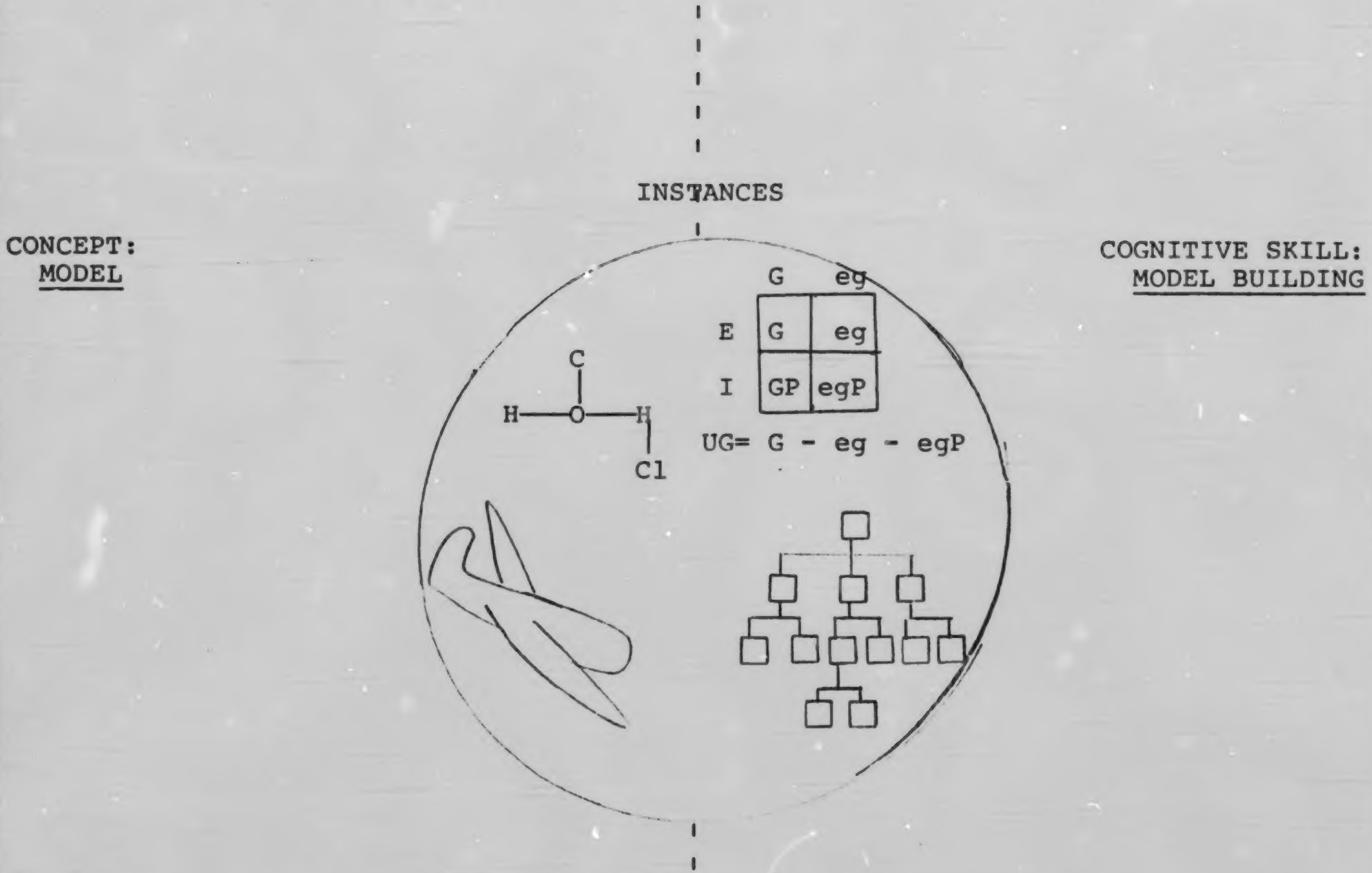

INSTANCES
CONCEPT: MODEL
COGNITIVE SKILL: MODEL BUILDING
C
H—O—H
Cl
G eg
E G eg
I GP egP
UG= G - eg - egP

Figure 9. Activating Cognitive Skills

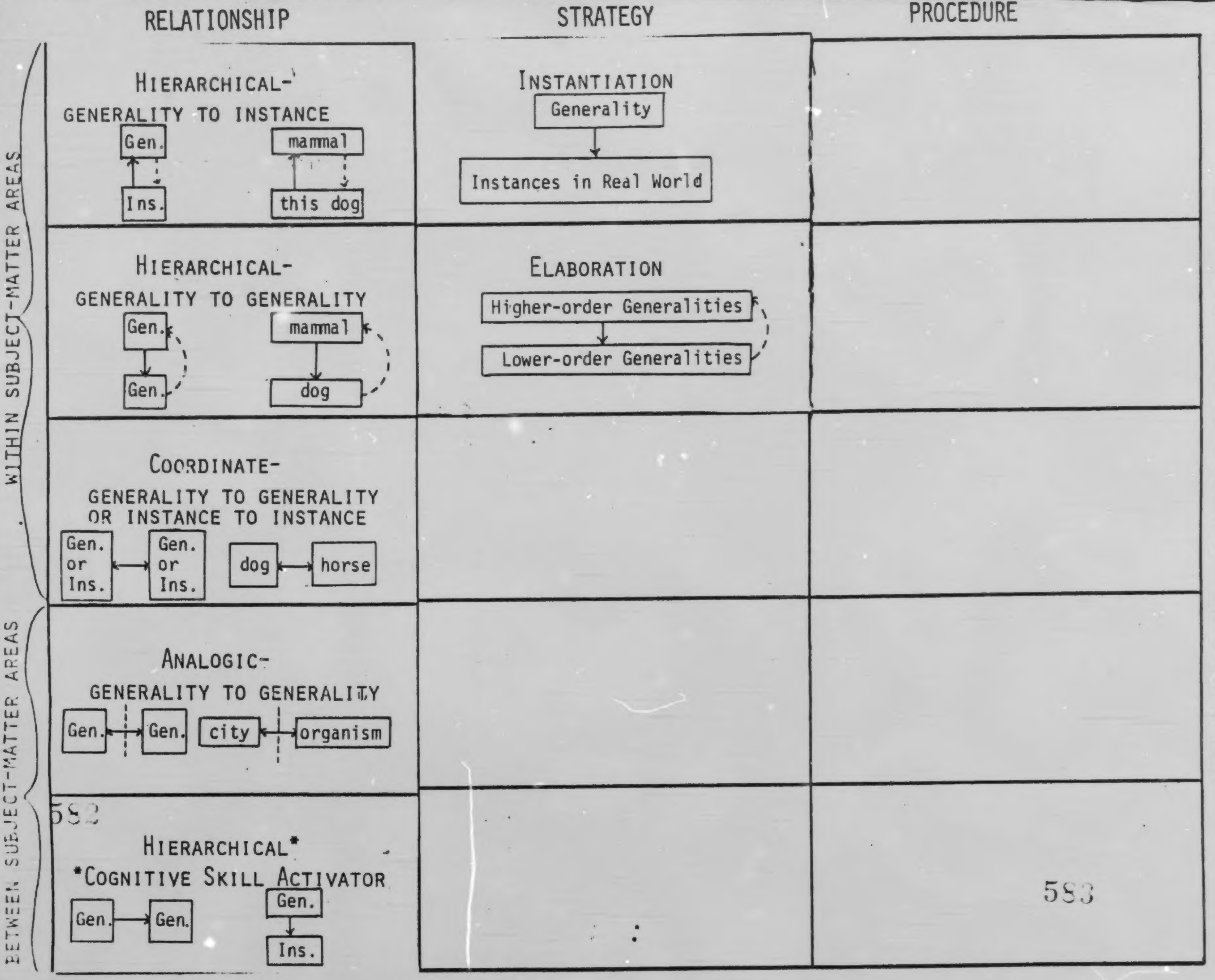

RELATIONSHIP
STRATEGY
PROCEDURE
WITHIN SUBJECT-MATTER AREAS
BETWEEN SUBJECT-MATTER AREAS
HIERARCHICAL-
GENERALITY TO INSTANCE
Gen.
Ins.
mammal
this dog
INSTANTIATION
Generality
Instances in Real World
HIERARCHICAL-
GENERALITY TO GENERALITY
Gen.
Gen.
mammal
dog
ELABORATION
Higher-order Generalities
Lower-order Generalities
COORDINATE-
GENERALITY TO GENERALITY
OR INSTANCE TO INSTANCE
Gen. or Ins.
Gen. or Ins.
dog
horse
ANALOGIC-
GENERALITY TO GENERALITY
Gen.
Gen.
city
organism
HIERARCHICAL*
*COGNITIVE SKILL ACTIVATOR
Gen.
Gen.
Gen.
Ins.

Figure 10. Strategies for Utilizing Hierarchical Relationships

582
583

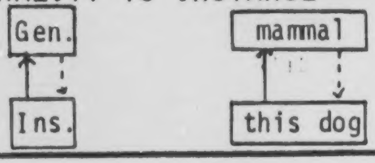
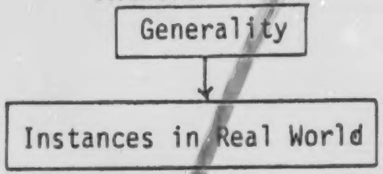
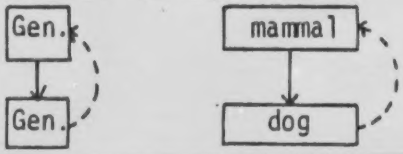
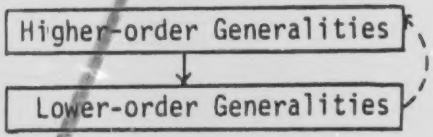
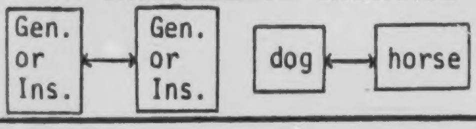
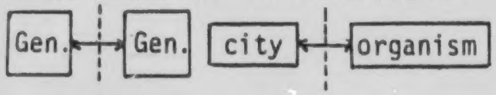
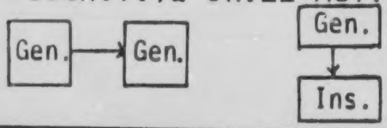
	RELATIONSHIP	STRATEGY	PROCEDURE
WITHIN SUBJECT-MATTER AREAS	HIERARCHICAL- GENERALITY TO INSTANCE  Gen. Ins. mammal this dog	INSTANTIATION  Generality Instances in Real World	
	HIERARCHICAL- GENERALITY TO GENERALITY  Gen. Gen. mammal dog	ELABORATION  Higher-order Generalities Lower-order Generalities	
	COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE  Gen. or Ins. Gen. or Ins. dog horse	SYNTHESIZE Among Generalities in Single Subject COMPARE & CONTRAST Instances In a Single Generality	
BETWEEN SUBJECT-MATTER AREAS	ANALOGIC- GENERALITY TO GENERALITY  Gen. Gen. city organism		
	HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR  Gen. Gen. Gen. Ins.		

Figure 11. A Strategy for Utilizing Co-ordinate Relationships

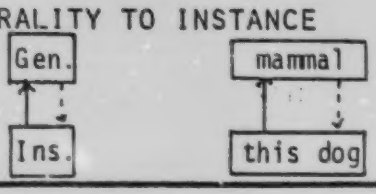
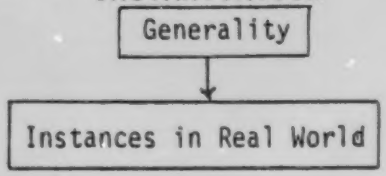
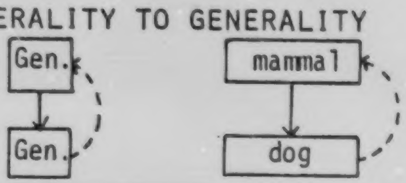
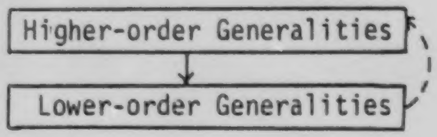
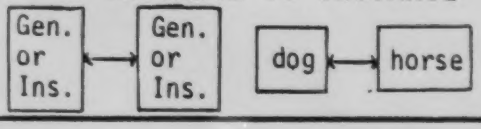
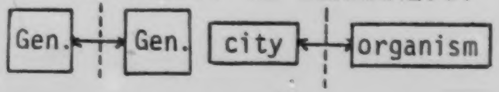
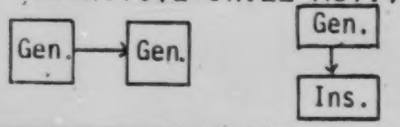
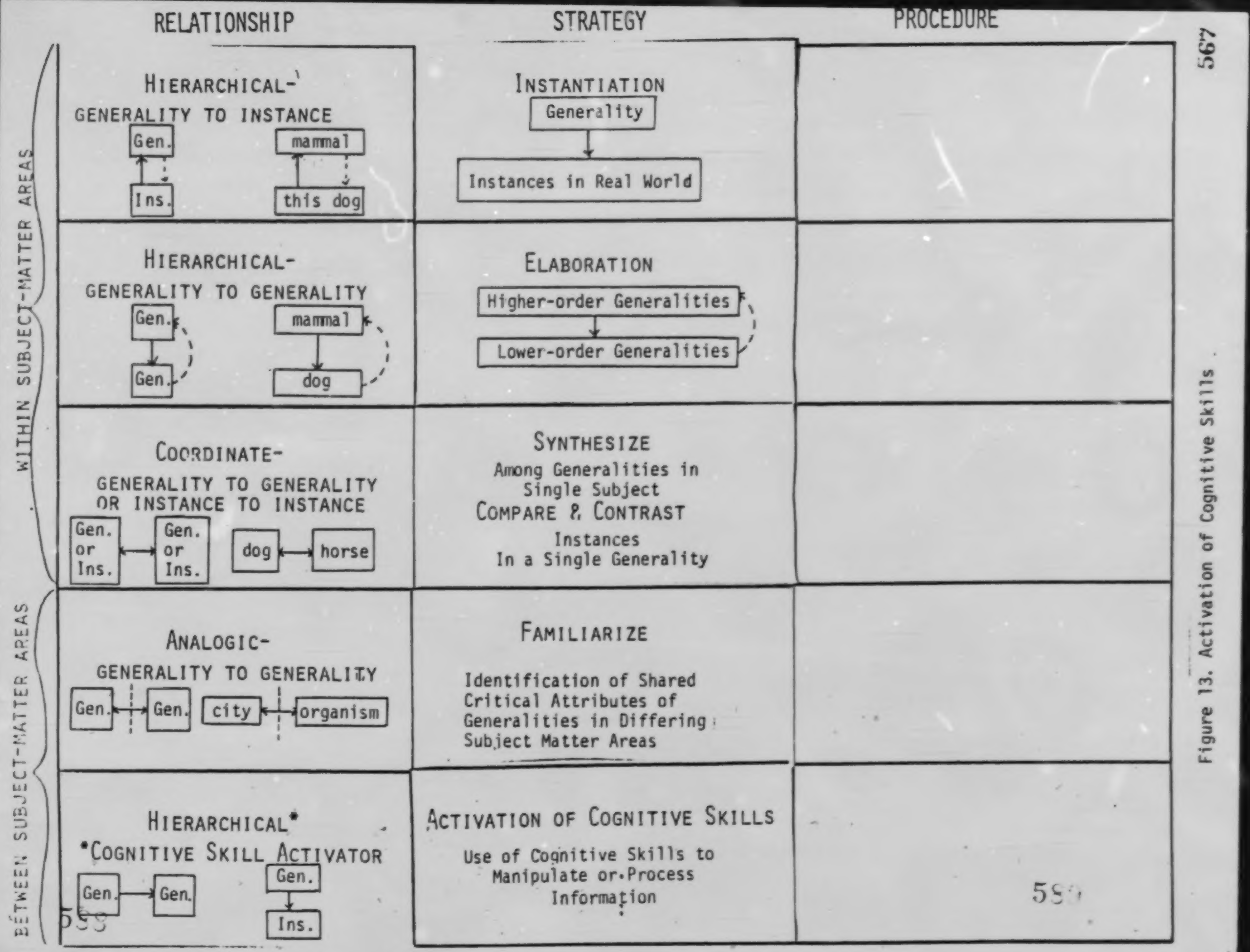
	RELATIONSHIP	STRATEGY	PROCEDURE
WITHIN SUBJECT-MATTER AREAS	HIERARCHICAL- GENERALITY TO INSTANCE  Gen. Ins. mammal this dog	INSTANTIATION  Generality Instances in Real World	
	HIERARCHICAL- GENERALITY TO GENERALITY  Gen. Gen. mammal dog	ELABORATION  Higher-order Generalities Lower-order Generalities	
	COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE  Gen. or Ins. Gen. or Ins. dog horse	SYNTHESIZE Among Generalities in Single Subject COMPARE & CONTRAST Instances In a Single Generality	
BETWEEN SUBJECT-MATTER AREAS	ANALOGIC- GENERALITY TO GENERALITY  Gen. Gen. city organism	FAMILIARIZE Identification of Shared Critical Attributes of Generalities in Differing Subject Matter Areas	
	HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR  Gen. Gen. Gen. Ins.		

Figure 12.--Analogy as an Instructional Strategy



	RELATIONSHIP	STRATEGY	PROCEDURE
WITHIN SUBJECT-MATTER AREAS	HIERARCHICAL- GENERALITY TO INSTANCE Gen. Ins. mammal this dog	INSTANTIATION Generality Instances in Real World	
	HIERARCHICAL- GENERALITY TO GENERALITY Gen. Gen. mammal dog	ELABORATION Higher-order Generalities Lower-order Generalities	
	COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE Gen. or Ins. ↔ Gen. or Ins. dog ↔ horse	SYNTHESIZE Among Generalities in Single Subject COMPARE & CONTRAST Instances In a Single Generality	
BETWEEN SUBJECT-MATTER AREAS	ANALOGIC- GENERALITY TO GENERALITY Gen. ↔ Gen. city ↔ organism	FAMILIARIZE Identification of Shared Critical Attributes of Generalities in Differing Subject Matter Areas	
	HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR Gen. → Gen. Gen. → Ins.	ACTIVATION OF COGNITIVE SKILLS Use of Cognitive Skills to Manipulate or Process Information	

Figure 13. Activation of Cognitive Skills

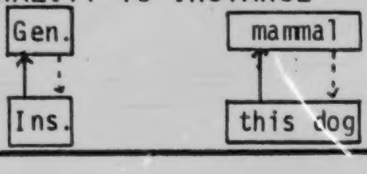
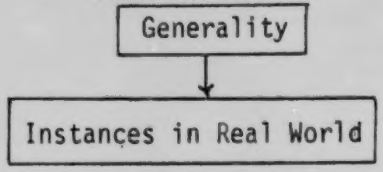
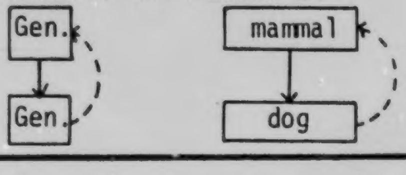
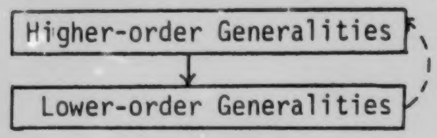
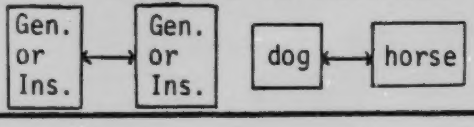
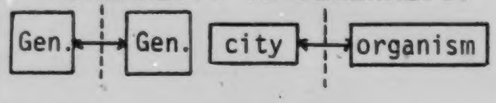
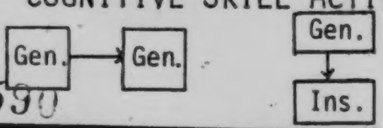
	RELATIONSHIP	STRATEGY	PROCEDURE
WITHIN SUBJECT-MATTER AREAS	HIERARCHICAL- GENERALITY TO INSTANCE  Gen. Ins. mammal this dog	INSTANTIATION  Generality Instances in Real World	1) Range of Difficulty 2) Divergence 3) Attribute Isolation 4) Alternative Representation
	HIERARCHICAL- GENERALITY TO GENERALITY  Gen. Gen. mammal dog	ELABORATION  Higher-order Generalities Lower-order Generalities	1) Determine Orientation Structure 2) Construct Epitome 3) Construct Elaborated Structure-Simple-Complex, General-Detailed
	COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE  Gen. or Ins. Gen. or Ins. dog horse	SYNTHESIZE Among Generalities in Single Subject	1) Identify Type of Relationship 2) Internal Synthesis 3) External Synthesis
		COMPARE & CONTRAST Instances In a Single Generality	1) Matched Non-Examples&Examples 2) Alternative Representation 3) Divergence
BETWEEN SUBJECT-MATTER AREAS	ANALOGIC- GENERALITY TO GENERALITY  Gen. Gen. city organism	FAMILIARIZE Identification of Shared Critical Attributes of Generalities in Differing Subject Matter Areas	1) Analogue of Same Content Type 2) Articulate Critical Attributes 3) Identification of Limitations Of the Analogy
	HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR  Gen. Gen. Gen. Ins.	ACTIVATION OF COGNITIVE SKILLS Use of Cognitive Skills to Manipulate or Process Information	1) Embedded Strategy Method 2) Detached Strategy Method

Figure 14. Designing Instruction that Makes Content Meaningful

TITLE: Narration, Detail and Event Relevance in Illustrated Materials

AUTHORS: Janet L. Whitaker

Howard J. Sullivan

*Narration, Detail and Event Relevance in Illustrated Materials

Janet L. Whitaker
West Virginia State College

Howard J. Sullivan
Arizona State University

Introduction

The investigation of the effects of pictures on information learning is a recently revived area of interest among educational researchers. Pictures have been studied under many experimental paradigms - the paired-associate paradigm being most popular. In Pressley's 1977 review of the studies concerned with imagery, employing pictures as stimuli, and children's learning, approximately 75% of the studies cited employed paired-associate tasks. Fewer studies have investigated prose materials (e.g. Rohwer & Harris, 1975; Rohwer & Matz, 1975) or investigated the relationship between the pictures used and the type of task to be performed or information to be learned (e.g. Dwyer, 1968b).

Two theories have been proposed to account for the communicative benefit of degree of detail in pictures. The realism theories of Dale (1946/1969), Morris (1946), and Gibson (1954) hold that the closer the picture represents reality, that is, the more detail, the easier it is to remember and comprehend the information in the picture. An alternative notion is the "relevant cue" theory of Dwyer (see Parkhurst, 1975, p. 176), which holds that when irrelevant information is eliminated, that is, less detail is presented, the easier it is to remember and comprehend the picture.

---

*Paper presented at annual convention of the Association for Educational Communications and Technology, Denver, April 21-25, 1980.

Dwyer (1968a) studied degree of picture detail with college and high school students but not with younger children. Pictures from a group of lessons on the heart varied from simple line drawings to detailed line drawings to photographs. These variations were examined in relation to the type of information to be learned and the task to be performed Dwyer found that simple line drawings were the most beneficial for most tasks and information types including drawing, identification, terminology definition, and comprehension. Realistic representations of the information, as, conveyed in photographs, did not improve performance in these areas.

In a study comparing photographs, paintings, and line drawings, Moore and Sasse (1971) found that students from grades three, seven, and eleven could answer more questions regarding the content of the line drawings than the content of the former two picture forms. However, some methodological problems can be found in the study. First, only nine pictures were used, three of each type being investigated. Each picture followed the same criteria for selection, such as no action and limited popular exposure, but the content of each picture was different. A more advantageous approach would be to keep picture content constant. Second, the questions about the pictures were asked immediately after each individual picture was shown. This procedure does not parallel classroom learning conditions, in which a block of information is usually presented before testing. Finally, because all questions were programmed into the timed presentation, each student was forced to answer questions at the same rate. Because of the above problems results and conclusions from the study have limited generality

In studies that examined comparative effects of narration, pictures, and narration plus pictures on children's recall of information (Guttmann, Levin, and Pressley, 1977; Rohwer & Harris, 1975; Rohwer & Matz, 1975), results indicate that narration plus pictures is the most effective treatment. If pictures and narration are more effective than pictures alone, verbal description may interact with the amount of detail present. Photographs with verbal description may be as effective as simple line drawings alone (see Guttmann et al, 1977).

The type of information to be learned can be categorized a number of ways. The foreground/background relationship or story relevant/story irrelevant information can be examined in prose learning studies. More story relevant information should be remembered than story irrelevant information. However, if narration is added, a strong cuing effect should be apparent and eliminate the superiority of the relevant events.

The purpose of this study is to investigate if, and to what extent, the amount of detail present in pictures has an effect on recall by children. By adding a narration of the information portrayed by the pictures, the interactive effect of picture detail and verbal description was examined in relation to children's performance on a recall test. Also, by testing the relevant and irrelevant information in narrated and non-narrated situations, the impact of narration on information type in prose learning was examined. The major hypotheses to be tested here were:

1. All picture plus narrative treatments facilitate recall of the information presented better than pictured passages without narration
2. Low detail line drawings facilitate recall of pictured information better than high detail line drawings.

3. High detail line drawings and low detail line drawings are equally effective when accompanied by narration.

4. Story relevant information is recalled better than story irrelevant information.

5. Story relevant and story irrelevant information in pictures are recalled equally well when the pictures are accompanied by narration.

Method

Subjects

Subjects were 81 third graders and 93 sixth graders from two, middle-class suburban schools in the Southwest.

Stimulus Materials

The treatment materials consisted of two seven-frame slide/tape stories adapted from a professionally developed reading series. The pictures for the slides were produced in two degrees of detail; high detail line drawings were taken directly from the series and low detail line drawings were abstracted from the originals by the experimenter by tracing. The two styles are shown in Figure 1.

Insert Figure 1 about here

The low detail pictures retained the outline shapes of the major characters and lines necessary to retain the perspective of the picture and convey the meaning of the picture. For example, the meaning of the picture from the "Man and Woman" story in Figure 1 was that the woman was in a messy kitchen. Therefore, simple information that would convey that meaning was retained and extraneous details, such as the mice, were omitted.

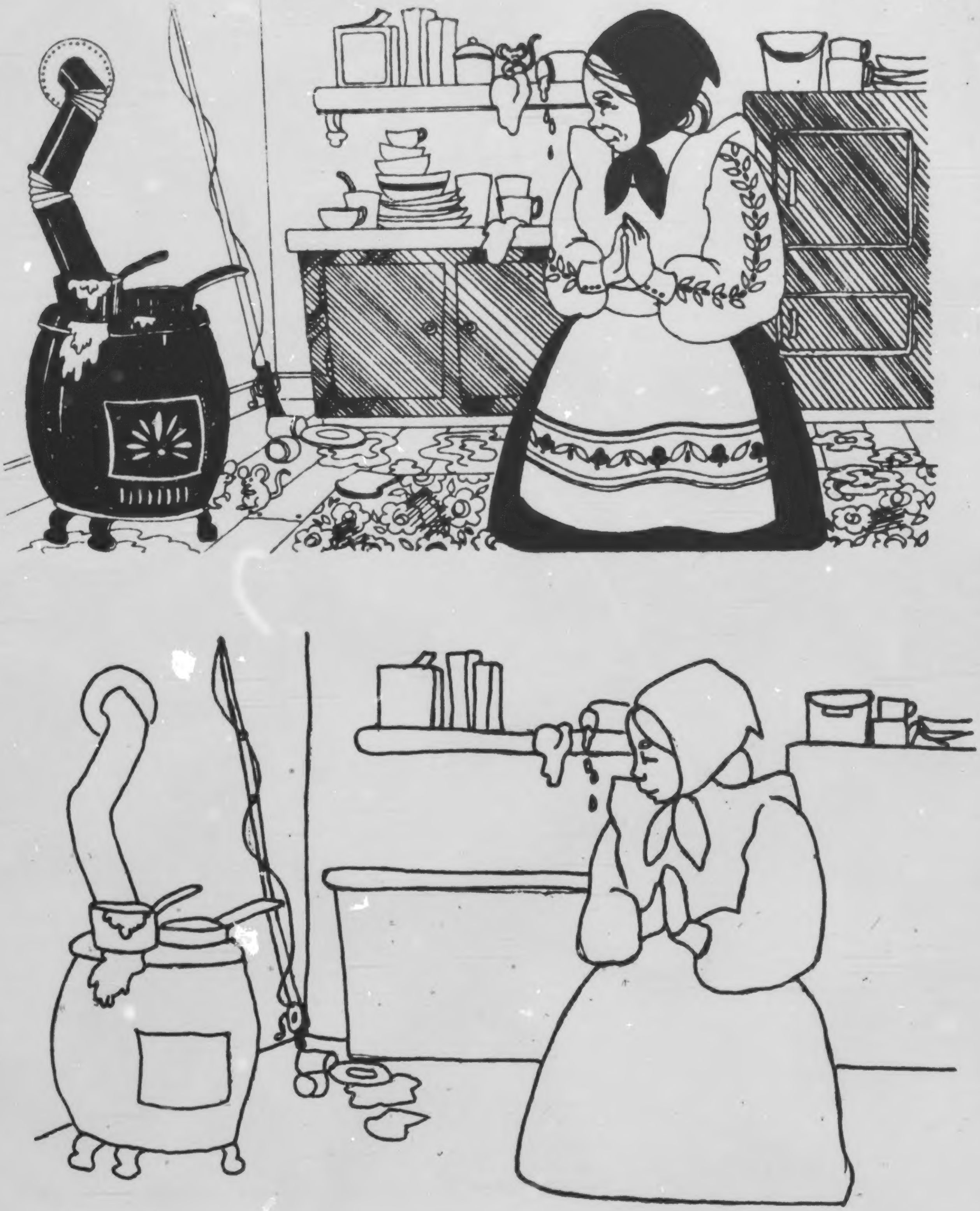


Figure 1. First picture in the "Man and Woman" story.

In the other story about "Kids", these same detail considerations were applied. The horizon line was retained for perspective because this story takes place outside in a playground. A frog defines a pond which is an important element for later in the story. However, embellishing details such as trees, reeds, and designs on the clothing were omitted.

Another modification of the pictures was the addition of an irrelevant event to each picture. These irrelevant events were irrelevant to the story line. For example, the major story line of the "Kids" story concerns the interaction of three children and a hat. Every frame also contains an irrelevant event such as an airplane flying in the sky or a baseball bat and ball lying beside a park bench that does not contribute directly to the story line of the children and the hat. These irrelevant events were always located in the background and the relevant events were always in the foreground. Relevant and irrelevant events were represented in each frame of both stories.

A taped narration was also provided to two of four treatment groups. The narration was a description of all relevant and irrelevant events of the stories. Each frame had an associated two or three sentence passage of description that was between eight and ten seconds long. The narration was written by the experimenter with content and level approved by practicing elementary teachers and pilot tested with a nursery school child. Meaning was judged to be clear in both cases.

The order of the relevant event description and irrelevant event description was randomly varied throughout the stories such that four times out of seven the relevant event was described first and the remaining three times the irrelevant event was described first for each frame.

Criterion Test

The criterion test consisted of 28 short answer questions about narrated and/or pictured information. Fourteen questions were asked about each story, two questions per picture. One of the questions was about a relevant event and one was about an irrelevant event. Figure 2 lists example of relevant and irrelevant event questions from each story. The question order paralleled the story order, "Kids" then "Man and Woman", and the story line of each story.

- - - - - - - - - - - - - - -

Insert Figure 2 about here

- - - - - - - - - - - - - - -

Each question was worth two points. One point was given to answers that were plausible answers but not evident of a non-guess response. For example, when asked what kind of table was in the playground, if the student answered 'wooden' one point was given. The correct answer was 'picnic' which was given two points. The inference that the table was wooden was acceptable as an inference but the table may well have been plastic. The answer was not entirely wrong as the answer 'dining room table' would be, therefore the student was not penalized with no points.

Twenty-eight points were possible for each story for a total of 56 points for the entire test. Students received a relevant event score and an irrelevant event score as well as a high detail score and low detail score for analysis purposes.

Procedures

Within each school each student was randomly assigned to one of four treatment groups. The first group viewed the low detail "Kids" story and the high detail "Man and Woman" story. The second group viewed the high detail

THE MAN AND WOMAN

1. WHAT WAS WRONG WITH THE KITCHEN?

____

2. WHERE WAS THE FISHING POLE IN THE KITCHEN?

____

THE KIDS

1. WHAT WAS THE BOY WITH THE HAT DOING IN THE FIRST PICTURE?

____

2. HOW MANY CHILDREN WERE SWINGING IN THE PICTURE?

____

Figure 2. Representative relevant and irrelevant event questions from both stories.

"Kids" story and the low detail "Man and Woman" story. Both the first and second treatments were narrated. The third group viewed the same pictures as the first group. The fourth group viewed the same pictures as the second group. Neither the third nor the fourth group heard a narration

Each treatment was administered in different locations concurrently Students were told that they were participating in an experiment to find out how children learn. They were then instructed to listen to the voice on the tape recorder The projection screen was blank. The tape recorded message was:

> "You are about to see (or see and hear, depending on the treatment group) two stories. One is about a man and woman and the other is about some children. Pay attention to what you see (and hear) because you will be asked questions about them afterward."

The slides were advanced automatically by a synchronizing inaudible pulse on the tape. Students first viewed the appropriate version on the "Kids" story which always advanced at the same rate with or without narration. Rate was determined by the amount of time necessary to speak the two or three sentences associated with the frame in the narrated treatment. A black slide appeared between the stories for approximately six seconds. The students then viewed the appropriate version of the "Man and Woman" story which also advanced at the same rate with or without narration.

After viewing the stories students received a copy of the test questions. They were told that the questions would be read aloud to them by the experimenter and to answer as well as they could. They were also told that it was permissable to leave blanks if they didn't know an answer. The experimenter read each question and allowed approximately 12 seconds between questions for answering No student indicated problems with keeping up this pace.

One week later the test was readministered in classrooms. Students did not know the delay test was to take place. The same procedure of test administration was followed on the retest.

Design

The design of the experiment was a 2 (narration) X 2 (detail level) X 2 (event type) X 2 (test trial) factorial design. Narration was a between subject factor with all other factors within subjects.

Results

Tables 1 and 2 display all means and cell sizes for immediate and delayed tests respectively. The statistical results were obtained by using a series of repeated measures ANOVA for main effects of the within-subject factors and their interactions with the between-subjects factor. Table 3 displays the summary results of these analyses. An independent T-test was used to test the difference between the means of the two levels of the narration factor.

Insert Tables 1, 2 and 3 about here

Narration

Significant main effects were obtained for the narration variable on both the immediate and delayed tests. The students in the narrated treatment groups scored significantly higher than the students in the non-narrated treatment groups, $\underline{t}$ (172) = 15.97, $\underline{p} < .001$, on the immediate test with means equal to 42.82 and 25.41 respectively, and $\underline{t}$ (154) = 11.05, $\underline{p} < .001$, on the delay test, means equal to 40.81 and 25.89 respectively.

Picture Detail

The low detail pictures allowed for significantly better recall of information than the high detail pictures on the immediate posttest, $\underline{F}(1,172) = 5.60$, $\underline{p} = .019$, means equal to 17.64 and 16.55 respectively. The main effect was not significant on the delayed test.

Table 1

MEAN SCORES ON IMMEDIATE TEST

			Detail		Event Relevance		
Narration	N		High	Low	Relevant	Irrelevant	Totals*
Present	88	$\bar{X}$	21.33	21.47	24.25	18.59	42.82
		SD	3.90	3.65	2.86	4.37	6.27
Absent	86	$\bar{X}$	11.76	13.73	18.37	6.96	25.41
		SD	5.49	5.30	5.25	3.84	8.02
Totals	174	$\bar{X}$	16.55	17.64	21.34	12.84	34.22
		SD	6.74	5.96	5.13	7.13	11.26

*Note: Totals for the narration factor are based on the total 28 item test. The means for the within-subject factors of detail and event relevance are based on 14 items for each level of the factor (14 high + 14 low, 14 relevant + 14 irrelevant).

Table 2

MEAN SCORES ON DELAY TEST

Narration	N		Detail		Event Relevance		
			High	Low	Relevant	Irrelevant	Totals*
Present	78	$\bar{X}$	20.70	20.21	22.43	18.29	40.81
		SD	4.58	4.44	4.25	4.72	8.39
Absent	78	$\bar{X}$	12.41	13.50	17.58	8.29	25.89
		SD	5.46	5.61	5.24	4.44	8.44
Totals	156	$\bar{X}$	16.56	16.86	20.01	13.29	33.35
		SD	6.52	6.07	5.34	6.79	11.09

*Note: Totals for the narration factor are based on the total 28 item test. The means for the within-subject factors of detail and event relevance are based on 14 items for each level of the factor (14 high + 14 low, 14 relevant + 14 irrelevant).

Table 3

Summary of the Repeated Measures ANOVA for the Three Within-Subjects Factors

Source	*df*	Mean Square	*F*	*p*
Detail				
Immediate				
Mean	1	101399.80469	3912.32410	<.001
Narration	1	6514.01794	251.33135	<.001
Error	172	25.91805		
Detail	1	97.10577	5.60447	.019
Detail X Narration	1	73.65753	4.25115	.041
Error	172	17.32649		
Delay				
Mean	1	87100.45996	2669.37122	<.001
Narration	1	4394.99719	134.69365	<.001
Error	154	32.62958		
Detail	1	7.08011	.38461	.536
Detail X Narration	1	48.49036	2.63411	.107
Error	154	18.40863		
Event Relevance				
Immediate				
Mean	1	101086.10156	3854.74283	<.001
Narration	1	6662.86414	254.07675	<.001
Error	172	26.22382		
Event Relevance	1	6333.85950	742.99323	<.001
Event Relevance X Narration	1	718.48569	84.28195	<.001
Error	172	8.52479		
Delay				
Mean	1	86500.00098	2554.34656	<.001
Narration	1	4305.38245	127.13802	<.001
Error	154	33.86385		
Event Relevance	1	3513.48767	354.66026	<.001
Event Relevance X Narration	1	515.38777	52.02453	<.001
Error	154	9.90663		

Table 3 (Continued)

Summary of the Repeated Measures ANOVA for the Three Within-Subjects Factors

Source	df	Mean Square	F	p
		Test Trial		
Mean	1	350543.84766	3223.90228	< .001
Narration	1	19681.01562	181.00352	< .001
Error	154	108.73278		
Test Trial	1	52.51282	3.77128	.054
Test Trial X Narration	1	155.12814	11.14074	.001
Error	154	13.92440		

Event Relevance

A significant difference was found between relevant event scores and irrelevant event scores, $F(1,172) = 742.99$, $p < .001$, on the immediate test with means equal to 21.34 for the relevant event and 12.84 for the irrelevant event, and $F(1,154) = 354.66$, $p < .001$, on the delay test with means equal to 20.01 for the relevant event and 13.29 for the irrelevant event. Students remembered more relevant events than irrelevant events.

Interactions

A significant interaction occured on the immediate posttest between narration condition and picture detail. The difference between low detail scores and high detail scores in the narrated treatment was significantly less than the difference between the low detail scores and high detail scores in the non-narrated treatment, $F(1,172) = 4.25$, $p = .041$. Figure 3 graphically displays this interaction.

- - - - - - - - - - - - - - -

Insert Figure 3 about here

- - - - - - - - - - - - - - -

Two interactions were also noted for the event relevance factor. The difference between the relevant event means and irrelevant event means in the narrated treatment was significantly less than the difference between the relevant event means and the irrelevant event means in the non-narrated treatment, $F(1,172) = 84.28$, $p < .001$, on the immediate test and $F(1,154) = 52.02$, $p < .001$, on the delay test. Figure 4 graphically displays these interactions.

- - - - - - - - - - - - - - -

Insert Figure 4 about here

- - - - - - - - - - - - - - -

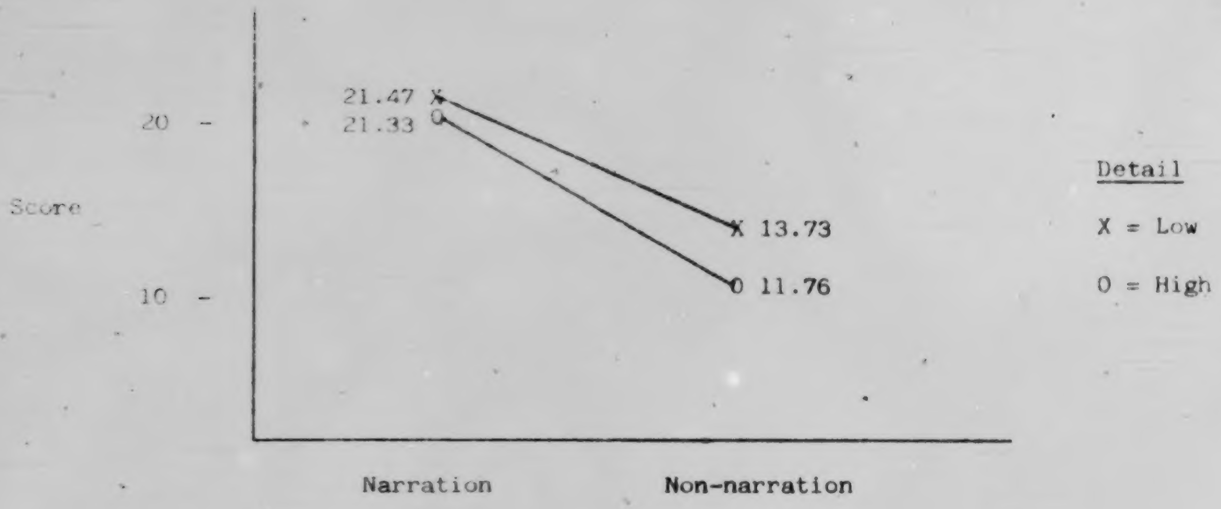


Figure 3. Graph of detail X narration interaction.

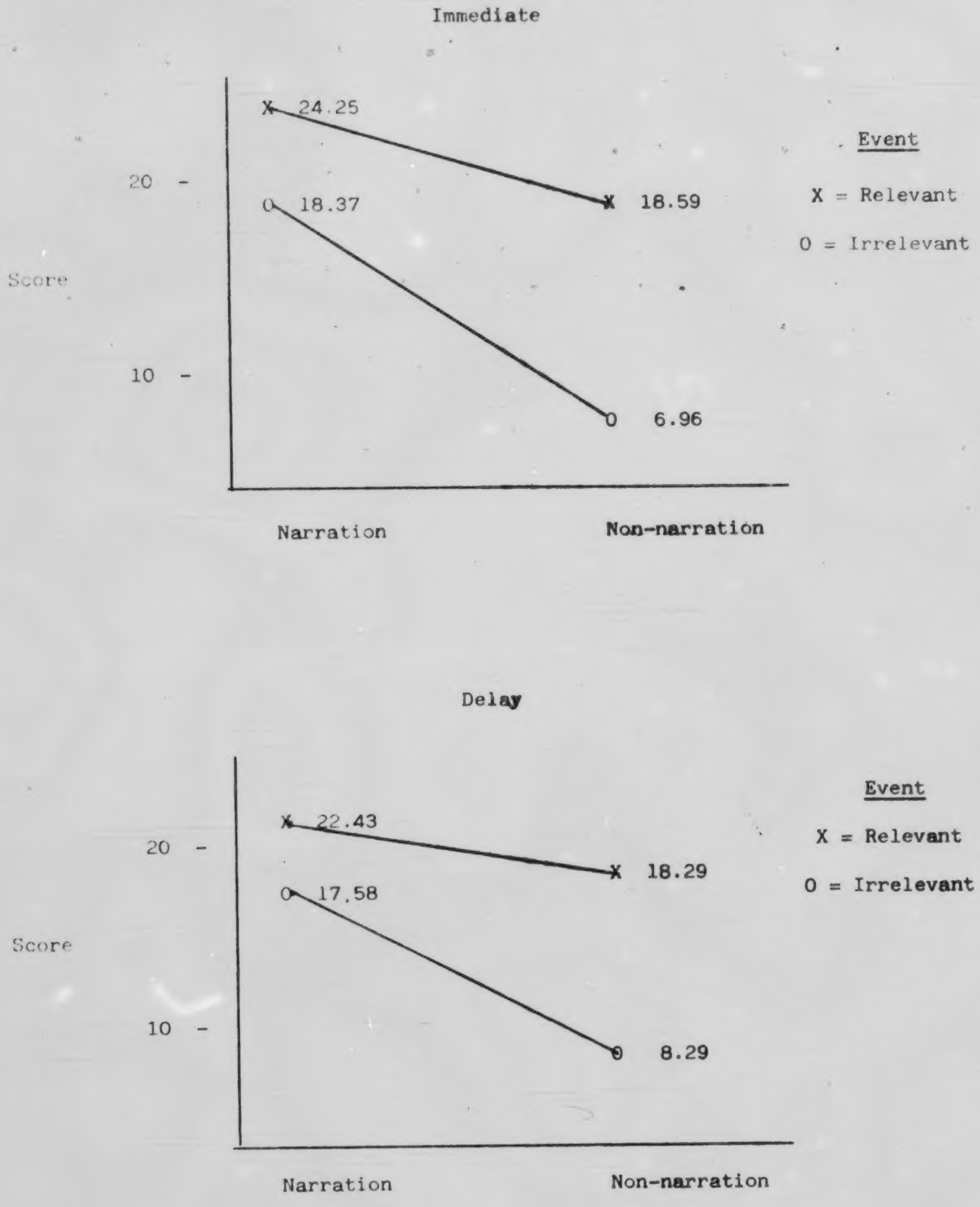


Figure 4. Graphs of event type X narration interactions on the immediate and delay tests

Other Findings

The difference between the means on the immediate and delay test approached significance, F(1,154) = 3.77, p = .054, with means of 34.22 and 33.35 respectively. A significant interaction between narration and test trial was noted, F(1,154) = 11.14, p = .001. The performance of the students receiving the narrated treatment decreased significantly more on the delayed test than the performance of the students receiving the non-narrated treatment. This interaction is graphically displayed in Figure 5.

- - - - - - - - - - - - - - -

Insert Figure 5 about here

- - - - - - - - - - - - - - -

Discussion

The purpose of this study was to investigate the effects of narration, amount of detail, and event relevance on children's recall of information in a story. Immediate and delay posttest results were obtained.

Narration

The narrated treatment group scored extremely higher than the non-narrated treatment group on both the immediate and delay test. Thus, the hypothesis that picture plus narrative treatments facilitate recall of information presented better than pictured passages without narration is accepted.

Detail

The results of the test of the detail factor were not as conclusive. On the immediate test, low detail pictures facilitated recall better than high detail pictures, p = .019. However, on the delay test the effect disappeared. When the actual means were examined on a practical basis, only one point separated the

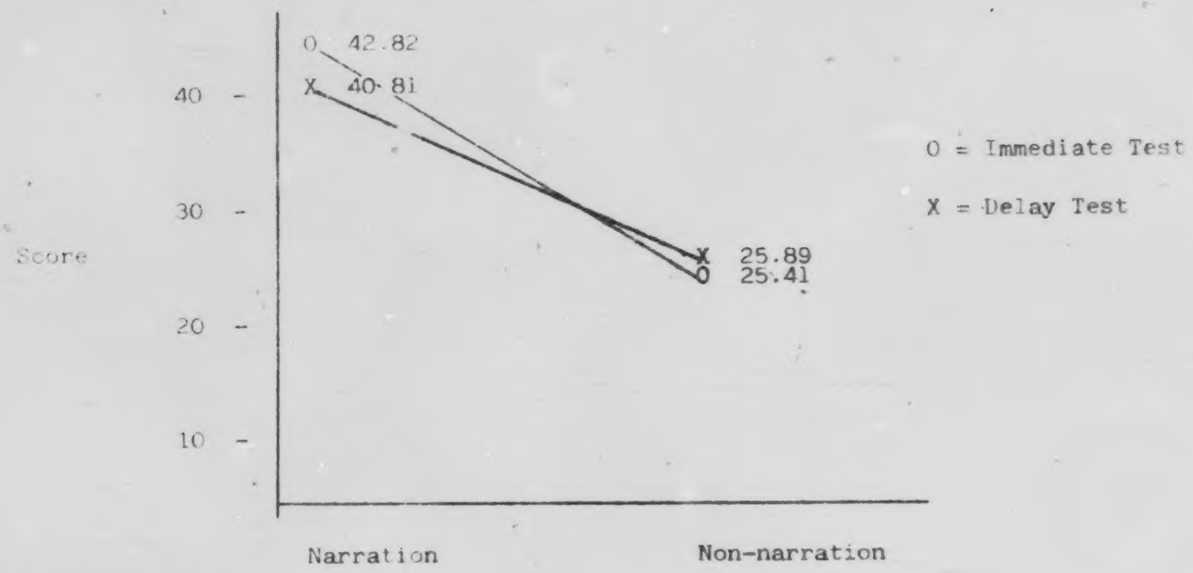


Figure 5. Graph of test trial X narration interaction.

means on the immediate test. Therefore, even though a statistically significant difference was achieved on the immediate test, the actual mean difference was so small as to have little practical significance. Thus, the hypothesis that low detail line drawings facilitate recall of pictured information better than high detail line drawings is rejected.

The effect of narration with regard to level of detail is also questionable. Statistically, narration did improve the effect of high detail line drawings so that it equalled the effectiveness of low detail line drawings on the immediate test. Again, this effect disappeared on the delay test because no difference existed between high and low detail levels. In other words, when a difference between high and low detail levels exists, added narration overcomes the superiority of low detail. Thus, the hypothesis, high detail line drawings and low detail line drawings are equally effective when accompanied by narration, is supported.

Event Relevance

The effect of event relevance on information recall was found to be very strong. Relevant events were better recalled than irrelevant events on both the immediate and delay test with mean differences of eight and seven points respectively. The hypothesis that events relevant to the story are recalled better than events irrelevant to the story is accepted.

The effect of narration with regard to event relevance was very strong. When relevant and irrelevant events were described in a narration, there was less difference between the means (six points) than when no narration was present (12 points) on the immediate test. On the delay test the mean differences for the event relevance factor were five points for the narrated condition and ten points for the non-narrated condition. Examination of the cell means shows that the narrated irrelevant events were remembered as well as the non-narrated relevant events. Thus, the hypothesis that story relevant and story irrelevant information in pictures are recalled equally well when a narration is present cannot be accepted because means were not equalized in the narration treatment. However, it could be stated that narration improves recall of irrelevant events more than relevant events.

Test Trial

Although no hypotheses were suggested regarding the test trial factor, some interesting results were obtained. Test trial as a main effect did not reach significance, $p = .054$. The actual mean difference was less than one point. Students tended to recall the stories after a week regardless of the treatment conditions.

The effect of narration with regard to test trial was also interesting. Students receiving narration recalled less after a week than students receiving no narration. In fact, the non-narrated treatment group mean increased .5 points on the delay test. The narrated treatment group mean dropped two points on the delay test.

Conclusions

Several interesting conclusions that have practical value can be drawn from this study. Also, some additional questions are raised.

Practical Applications

The effect of narration on recall is great. Whenever possible narration should be provided with picture sequences of a story nature. Narration overcomes the effect of picture detail and improves recall of less important events in the story. Students recall more of everything, not just main events. In addition, even though less information is retained over time when narration is provided and the same amount of information is retained when narration is not provided, the amount forgotten is negligible so as not to effect the superiority of narration.

The effect of level of detail in line drawings does not seem to be consequential over time. In the short run, low detail line drawings facilitate recall better than high detail line drawings. Over time, it doesn't appear to make any difference whether detail is high or low. The addition of narration improves the effectiveness of high detail line drawings. But, over time, this boost also disappears. It seems that it is more important to be concerned with providing narration than to be concerned with detail in the pictures. When narration is not an option, low detail pictures will facilitate recall better than high detail pictures.

Narration also affects the memorability of irrelevant and relevant events. When presenting a story without narration, events relevant to the story line will be easier to recall than less relevant events. To increase the number of less relevant events remembered, a narration should be added. This also will increase the number of relevant events remembered.

Theoretical Concerns

As a result of this study, the realism theory versus "relevant cue" theory debate is put in a different light. The strong effect of narration overwhelms the concern for detail level in line drawings. In this study, results showed that low detail representations (relevant cue) were as equally effective as high detail representations (realism) over time. It was more important to consider the complexity of the media, narration plus pictures, and the importance of the content to the story being told (event relevance).

Further Research

At least two lines of further research seem appropriate based on the present findings. One involves investigation of the retention of information and its relationship to picture characteristics. The second relates to the degree of detail differences necessary to elicit recall differences. Research on these issues should help increase our understanding of the effects of picture characteristics on short-term and longer-term memory for meaningful material.

References

Dale, E. Audio-visual methods in teaching. New York: Dryden Press, 1969. (Originally published, 1946.)

Dwyer, F. M. Effect of varying amount of realistic detail in visual illustrations designed to complement programmed instruction. Perceptual and Motor Skills, 1968, 27, 351-354.

Dwyer, F. M. Effect of visual stimuli on varied learning objectives. Perceptual and Motor Skills, 1968, 27, 1067-1070.

Gibson, J. J. A theory of pictorial perception. Audiovisual Communication Review, 1954, 1, 3-23.

Guttmann, J., Levin, J. R., and Pressley, M. Pictures, partial pictures and young children's oral prose learning. Journal of Educational Psychology, 1977, 69, 473-480.

Moore, D. M. and Sasse, E. B. Effect of size and type of still projected pictures on immediate recall of content. Audiovisual Communication Review, 1971, 19, 437-450.

Morris, C. W. Signs, Language and Behavior. New York: Prentice Hall, 1946.

Parkhurst, P. Generating meaningful hypotheses with aptitude-treatment interactions. Audiovisual Communication Review, 1975, 23, 171-183.

Pressley, M. P. Imagery and children's learning: Putting the picture in developmental perspective. Review of Educational Research, 1977, 47, 585-622.

Rohwer, W. D. and Harris, W. J. Media effects on prose learning in two populations of children. Journal of Educational Psychology, 1975, 67, 651-657.

Rohwer, W. D. and Matz, R. D. Improving aural comprehension in white and black children. Journal of Experimental Child Psychology, 1975, 19, 23-36.

TITLE: The Interactive Effects of Color and
Cognitive Style on a Pictorial Recognition
Memory Task

AUTHOR: Theodora J. Wieckowski

THE INTERACTIVE EFFECTS OF COLOR AND COGNITIVE STYLE ON A PICTORIAL RECOGNITION MEMORY TASK

Theodora J. Wieckowski, Ph.D.
Pittsburgh Public Schools
857 Ford St.
Pittsburgh, PA 15205

In past years media research has often been evaluative in nature, comparing learning from one medium with learning from another. During the last decade this type of comparative research has often been criticized because of its failure to produce useful research questions, significant findings, or a theory of instruction. Many have hypothesized that the problem may lie in the failure to conduct research that goes beyond the descriptive stage and into the prescriptive stage (Allen, 1971; Salomon and Clark, 1977). Some suggest that media must be defined in terms of unique attributes which fulfill unique psychological functions (Salomon, 1971). The cognitive and non-cognitive characteristics of the individual, the ultimate learning task, and the best method of achieving this goal all interact to produce the desired result. Aptitude-treatment interaction research is beginning to provide specific guidelines that may establish principles of instructional design which consider these three elements. But a need still exists to go beyond defining interactions in terms of the general intellectual abilities of individuals and the broad levels of learning or of instructional events. It is to meet this need that this particular study was designed.

The elements investigated in the study were chosen to answer the demand for specificity in the media, learner and task variables. Much comparative research has been conducted examining the usefulness of color in facilitating learning. The investigations have often produced conflicting evidence. VanderMeer (1954) found that students preferred color films to black and white films, but there was no correlation between preference and learning in immediate verbal posttests. Fullerton (1956) and Kanner and Rosenstein (1960) found similar results. More recent research conducted by Dwyer (1971) and Berry (1974) has found that color is a significant design factor. When the results of these studies are taken into consideration, it seems apparent that as Otto and Askov (1968) indicated the "cue value of color in learning is still essentially unclear" (p. 161).

One variable that may be interacting with color to produce these inconclusive results is that of cognitive style. This learner characteristic involves the unique ways the individual perceives his environment. The two specific styles of field dependence-independence and reflectivity-impulsivity are illustrative of those being researched in relationship to the perceptual area of cognition. Each of these represents a different aspect of stimulus reception capabilities in the learner and thus relates to variations in display characteristics, particularly in visual presentations.

The question now apparent is how do these two cognitive styles interact with color in achieving a specific learning task. The task variable chosen to examine this relationship is that of pictorial recognition memory. It is one of the most basic types of learning involving visual perception, yet one that is not entirely understood. Research in the area of visual learning has indicated that pictures are remembered better than either words or sentences (Shepard, 1967; Standing, 1973). This finding applies to such fundamental tasks as simple visual recognition as well as to more advanced types of learning, such as concept attainment and principle development (Gropper, 1966). Many of the characteristics which facilitate or hinder visual recognition or concept attainment, however, are yet to be investigated.

These three variables coalesce and form a sound rationale for assuming the existence of a reliable interaction, for the learning task involves a visual presentation which must be perceived, encoded, and retrieved, a function of cognitive style, and the display characteristic of color may determine how successfully this is accomplished. Thus the purpose of the study evolved into an investigation of the interaction of field dependence-independence and reflectivity-impulsivity, both individually and simultaneously, with color cueing, and pictorial recognition memory in elementary school children.

Following the principles of aptitude-treatment interaction research which involve task, learner, and treatment analysis to determine potential interactions (Cranbach and Snow, 1977) the following research questions were formulated:

1. Is there a significant interaction between the presence or absence of color in a pictorial presentation and the cognitive style variable of field dependence-independence?
2. Is there a significant interaction between the presence or absence of color in a pictorial presentation and the cognitive style variable of reflectivity-impulsivity?
3. Is there a significant interaction between the presence or absence of color in a pictorial presentation and the cognitive style variables of reflectivity-impulsivity and field dependence-independence when considered simultaneously within the individual?

Related Research

Research in each of the variables under investigation, that of cognitive style, particularly field dependence-independence, and reflectivity-impulsivity, pictorial recognition memory, and color in visualized learning has been conducted with each element being considered independently. Limited work has been done in interrelating cognitive style and color cueing and none in which a dual cognitive style component in each subject was studied in relationship to a learning task.

Research in the area of cognitive styles has indicated that these are "individual variations in modes of perceiving, remembering, and thinking, or as distinctive ways of apprehending, storing, transforming, and utilizing information" (Kogan, 1971, p. 224). Witkin, Moore, Goodenough, and Cox (1977), basing their conclusions on research in the area of field dependence-independence, have enumerated the essential characteristics of cognitive styles. First, cognitive styles are concerned with the form rather than the content of cognitive ability. They refer to how individuals differ in what is perceived, thought, learned, or resolved not to how much is perceived or learned. Second, cognitive styles are pervasive dimensions and are not only a part of cognition but also of personality. A third characteristic is that of stability over time. A person who has a particular style one day will have the same style the next day, month or year. Related to this stability is the apparent general resistance of certain styles to training or change. Fourth, with regard to value judgments, cognitive styles are bipolar. Each pole has certain characteristics which are valuable in meeting the needs of a particular situation. Because of these characteristics cognitive styles are influential during all learning and thus should be considered when planning instructional situations and materials.

Two particular cognitive styles, those of field dependence-independence and reflectivity-impulsivity are evident in visual perception and thus function in situations involving learning from pictures.

Field dependence-independence concerns the ability to perceive details as discrete from their backgrounds and to overcome an embedding context (Witkin, Dyk, Faterson, Goodenough, Karp, 1974). An example of such a task is the Embedded Figures Test (EFT) (Witkin, 1971) in which the subject is shown a simple figure and then required to find it in a complex design which is so patterned that each component of the simple figure is made part of a clear-cut sub-whole of the pattern. The simple figure is thereby effectively "hidden". The person who experiences in a field independent fashion has the ability to perceive items as discrete from their background and to reorganize a field when the field is organized. The field independent individual is also able to impose structure on a field and so perceive it as organized when the field has relatively little inherent structure. Field dependent individuals are less likely to attempt to structure or restructure stimuli, thus they usually experience ambiguous stimuli as vague and undefined.

The cognitive style of the reflectivity-impulsivity also has direct implications in the area of visual perception. It involves the individual's evaluation of his own cognitive products--that is, his willingness to pause and reflect on the accuracy of his responses. Some individuals act upon the first solution that enters their mind, paying little attention to its appropriateness or validity. These individuals are classified as impulsive. Other individuals, the reflectives, devote considerable time to reflection before opting for a specific alternative in a situation of response uncertainty (Kagan, Rosman, Day, Albert, Phillips, 1964). The test designed to indicate this perceptual style, the Matching Familiar Figures Test (MFFT) (Kagan, 1969), requires discrimination of visual detail presented via pictorial stimuli. Each item on the test consists of a standard and six alternatives, one of which is identical to the standard. The individual is asked to select the matching alternative. The subjects who respond quickly often err (impulsives), whereas those who pause to reflect on response alternatives are more often correct (reflectives).

Research conducted to study antecedents of the dimension have centered on scanning techniques and attention deployment. Siegel, Kirasic, and Kilburg (1973) indicated that on tasks highly correlated with the MFFT, both reflective and impulsive children utilize feature differences in a problem solution, but reflective children tend to perform a more thorough and detailed feature analysis of the stimulus array. Drake (1970) further concluded that the impulsive child simply searches for a variant that globally resembles the standard and is not very discriminating or particular in his viewing. Impulsive subjects do not scan all of the alternatives in the MFFT before venturing a solution, whereas reflective children make careful visual searches of the standard and all of the variants before they are willing to offer a response. This complete search made by reflective individuals makes possible better identification of the variants and successful encoding of these variants for storage and subsequent comparison with the stimulus.

One of the most basic types of learning that involves visual perception and thus may be influenced by these two styles is that of pictorial recognition memory. It has been defined as the ability to perceive, encode, store, and retrieve visual information (Standing, Conezio, and Haber, 1970). Cognitive styles have also been defined as "distinctive ways of...storing...and utilizing information" (Kogan, 1971, p. 244). It, therefore, appears that the two variables in learning are closely related. Research in this area has begun to investigate this relationship with varying results. Myatt (1974) concluded that cognitive style as measured by the EFT did not appear to be a factor in pictorial recognition memory. Rudnick (1974), who conducted an experiment involving auditory masking, color, and perceptual style, found, however, that field independent individuals recognized significantly more pictures than did field dependent subjects.

In an experiment conducted by Siegel (Siegel, et al., 1973) preschool children grouped as reflective or impulsive were found to differ significantly in a forced-choice recognition memory task. Reflective preschool children made more correct recognition choices than did impulsive children when correct responses could be made on the basis of verbal labels, visual feature analysis, or both. This finding seems to indicate that detailed visual feature analysis is a significant component of reflectivity-impulsivity.

An element which may be interacting with cognitive style to produce these results is color. A number of studies have been conducted to investigate the interrelationship of these two variables. Rudnick (1974), while researching visual recognition and recall in children categorized as field independent, moderately field independent and field dependent, found that in all groups color visuals were recognized to a significantly greater degree than black and white visuals. Myatt (1974), however, concluded that color was not a significant factor in pictorial recognition in children and adults similarly grouped. Chan (1974), investigating color mode and reflectivity-impulsivity found that color stimuli on the MFFT facilitated learning when the intra-array similarity of each visual presentation was high. The implications appear to be that the greater the similarity among variants in the visual array, the more effectively color stimuli function as facilitators of matching.

In situations where color cueing appears to be significant, a number of reasons have been suggested to explain this superiority. Dale (1969) theorizes that color in a visual presentation can perform three major tasks: 1. It can heighten realism; 2. It can distinguish and emphasize detail or contrast; 3. It can produce esthetic effects. In the case of an impulsive individual, the added realism and the esthetic effects produced by using color may increase the time spent scanning a visual thus allowing more of the stimulus variables to be encoded for later retrieval. The use of color to provide contrast may aid the field dependent individual to disembed the figure from the ground more easily thus allowing more information to be stored in memory.

There is also evidence that children who are classified as impulsive do not encode all stimulus information and thus respond to color more than reflective children (Katz, 1971). Rudnick (1974) speculated that differences in subjects' scores on recognition of color and monchrome photographs may be due to a loss of detail in the monochrome photographs. This lack of detail may explain why field dependent subjects and impulsive subjects do not perform as well as their counterparts on recognition memory tests. The field dependent subjects may need the extra detail in order to disembed information found in visuals from its background. The impulsive individual, since he does not scan as broadly and as systematically, may need the detail as an added cue for encoding and retrieval.

In summary, limited work has been done in interrelating cognitive style and color cueing and none in which a dual cognitive style component in each subject was investigated. Yet research in the use of color in visual presentations has often produced conflicting results. A factor that may be contributing to this situation is that of cognitive style. Careful task analysis indicates that the components of a pictorial recognition memory task include the ability to visually discriminate and separate details of a picture from their background and to analyze the stimulus array for encoding purposes so that a recognition decision can be made at a later time. An examination of learner characteristics or aptitudes suggests that the cognitive styles of field dependence-independence and reflectivity-impulsivity may function in such a task.

The media attribute of color can be hypothesized as an interacting variable. Because of the added realism and the esthetic effects produced by the use of color, it can be assumed that impulsive individuals will spend more time scanning a visual, thus allowing more of the stimulus variables to be encoded and eventually retrieved. The use of color can also result in increased time spent in scanning the response alternatives presented during the recognition test. This can result in a more accurate response and a higher recognition rate. The addition of color also results in added detail which can aid the impulsive individual in retrieval by providing more visual cues for encoding. Thus, the realism, the esthetic effects, and the added detail resulting from the use of color can compensate for the impulsive individual's tendency to scan visuals quickly and unsystematically.

The addition of color can also aid the field dependent individual in a pictorial recognition memory task. The ability of color to distinguish and emphasize detail or contrast will enable the field dependent individual to disembed the figure from the ground more readily, therefore allowing more information to be stored in memory. Thus, color may compensate for the inability of field dependent individuals to perceive figure from ground by providing visual cues that may make the completion of this task possible.

Methodology

The primary purpose of the study was to investigate the relationship between the cognitive styles of learners and their ability to correctly identify previously seen pictorial materials presented in color or black and white. The statistical model chosen to analyze the various interactions was that of regression analysis. The following null hypotheses can, therefore, be formulated.

Ho: 1. There is no significant difference between the slopes of lines used to predict performance on a color or black and white memory task from field dependence-independence scores.

Ho: 2. There is no significant difference between slopes of the lines used to predict performance on a color or black and white memory task from reflectivity-impulsivity scores.

Ho: 3. There is no significant difference between the slopes of the planes used to predict performance on a color or black and white memory task from scores of field dependence-independence and reflectivity-impulsivity when considered simultaneously.

The subjects for this study were 53 third and fourth grade students from the Pittsburgh Public School System. The children were from middle class socio-economic backgrounds with I.Q.'s falling into the average or above range as measured by the Otis-Lennon Mental Ability Test given in the second grade. None were found to be color blind when given the Ishihara Color Vision Test.

The testing instruments which were used to determine the two cognitive styles under consideration were the Children's Embedded Figures Test (CEFT) (Karp and Konstadt, 1971) and the Matching Familiar Figures Test (MFFT) (Kagan, 1969). The CEFT is an individually administered test determining the degree of field dependence-independence in children. This instrument has no specific time limit and the total score is equal to the number of items identified. Twenty-five is the maximum score which indicates a large degree of field independence.

The studies conducted to determine the reliability and validity of the CEFT indicate that it is both a valid and reliable instrument for determining field dependence-independence in children 12 years of age and younger. The reliability coefficients for the age group under consideration, 9 to 10 years of age, are .89 for males, .89 for females and .88 for the group as a whole. Validity coefficients indicate that for ages 9 and 10 the coefficients are .70 for males, .73 for females, and .71 for the standardizing group in general (Witkin, et al., 1971).

The MFFT is also an individually administered test which determines the degree of reflectivity-impulsivity. It is a timed test with a dual score consisting of response latency to first response and number of errors for each of the twelve test items. Children above the group median in response latency and below the group median in error frequency are considered to be reflective. Children below the group median in response latency and above the group median in error rate are considered to be impulsive.

Reliability coefficients, obtained by Egeland (1974) using equivalent forms of the same test for adults and children, ranged from .92 to .98 but whether these figures applied to response latency, errors, or both was not indicated.

The stimulus materials for the recognition task consisted of a set of 400 color slides of natural objects and scenes. Slides with any verbal material, recognizable human figures or unique features were eliminated. This group of 400 slides was randomly divided into halves. One half, or 200 slides, were photographically recopied into black and white using a Honeywell Repronar Slide-Duplicator, Kodak Panatomic X film, and Kodak Direct Positive Processing Chemistry. The remaining 200 slides were retained in color. Each group of 200 slides was randomly divided in half a second time. One half, or 100 slides in each color mode, were designated the learning or stimulus slides and the other 100 in each group were designated the distractor slides. The learning slides were duplicated and randomly combined with the distractor slides to form the recognition set.

The 53 subjects were individually administered the CEFT and the MFFT during two separate testing sessions one month apart. Since the "scores from any test of field dependence form a continuous variable" (Witkin, et al., 1971, p. 4) the subjects were not dichotomously grouped as field dependent-independent as in previous studies. Each subject was given a score on a continuous scale ranging from 0 to 25, with 0 indicating extreme field dependence and 25 extreme field independence. In this way all the subjects, not just the highest and lowest 1/3 or 1/4 of the group, were studied and vital information was gained concerning individuals who are not dominantly field dependent or field independent and who have long been neglected in experimental research.

The MFFT has also been criticized for artificially dichotomizing the continuous variable of reflectivity-impulsivity thus squandering potentially valuable discrimination information (Kerlinger and Pedhauser, 1973). For this reason the subjects in this study were given a dual score consisting of response latency and error rate, but were not grouped as reflective or impulsive. The dual score was then converted into a ratio score of response errors over response latency. Thus an individual with a response error score of 10 and a response latency score of 100 would have a ratio score of .1. Individuals who tended to be reflective would have smaller ratio scores.

Four to six weeks after the completion of the testing sessions to determine cognitive style, the first session involving the recognition task took place. All subjects were shown 100 stimulus slides, 50 black and white slides and 50 color slides randomly chosen from the original set of stimulus slides. This was followed by the recognition set of 200 slides evenly divided between both color modes. These included the 100 stimulus slides just seen and 100 distractor slides. At a second testing session, one month later, a similar procedure was followed using the remaining 100 stimulus slides and 100 distractor slides.

The "forced-choice" procedure for recognition experiments was followed. In this method a recognition set consists of an old stimulus item presented simultaneously with one or more new or distractor items. The subject must discriminate the old item from the new ones (Adams, 1976). In this study the subjects were shown the stimulus item and one distractor item.

Each subject was shown the group of 100 randomly sorted stimulus slides each for an interval of 2 seconds. After the first 50 stimulus slides had been viewed a 5 minute rest period was given before the recognition set of slides was shown. On each recognition item two slides were presented side by side, one a randomly selected copy of a stimulus slide and the other a randomly chosen distractor slide both of the same mode, color or black and white. The slides were randomly placed in a right or left hand position on the screen and labeled A or B. Each subject was instructed to state whether slide A or slide B had been seen before. Each recognition item was presented for an interval of 8 seconds. A 3 minute rest period was given after the first 50 test items. One month later the subjects were shown the second group of stimulus and recognition slides. The same procedure was followed on this occasion.

Results

Ho: 1. There is no significant difference between the slopes of the lines used to predict performance on a color or black and white memory task from field dependence-independence scores.

This hypothesis was tested by means of a linear regression analysis. The intercepts and the slopes for each regression equation are reported in Table 1.

Table 1

Linear Regression Equations - CEFT

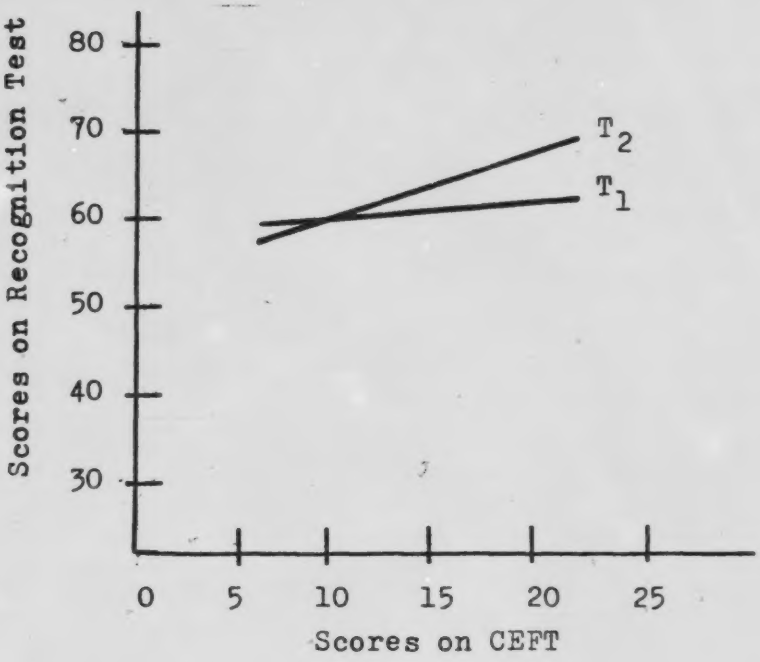
Treatment	Intercept	Slope
Color	53.367	.722
Black and White	58.221	.169

The slopes for the two regression lines were tested by an F statistic and found to be significant. ($F = 9.071$; df = 1/51; $p < .01$). Therefore, Hypothesis 1 was rejected. The slopes of the prediction lines for field dependence-independence and the two treatment modes were not equal. Thus an interaction existed between the aptitude variable of field dependence-independence and the design element of color.

The regression lines were then plotted to determine the type of interaction that existed, i.e., ordinal or disordinal. The results of this operation are shown in Figure 1.

As seen in Figure 1 a disordinal interaction existed with regression lines for color and black and white intersecting within the range of the aptitude variable in question. In this case the intersection point was approximately 9. Such findings imply, in general, that assigning subjects on opposite sides of the intersection to alternative treatments would be instructionally sound. Thus, subjects to the right of the point of intersection would be expected to benefit more from the color treatment than from the black and white treatment, while those to the left of the point of

Figure 1. Regression Lines for CEFT and Treatment Mode



T_1 - Black and White

T_2 - Color

intersection would probably benefit more from the black and white treatment than from the color treatment. In the present study the color treatment was superior to the black and white treatment through most of the aptitude range. There were only 4 individuals for whom the black and white treatment was the superior treatment.

Ho: 2. There is no significant difference between the slopes of the lines used to predict performance on a color or black and white memory task from reflectivity-impulsivity scores.

This hypothesis was also tested by means of a linear regression analysis. The intercepts and the slopes for each regression equation are reported in Table 2.

Table 2

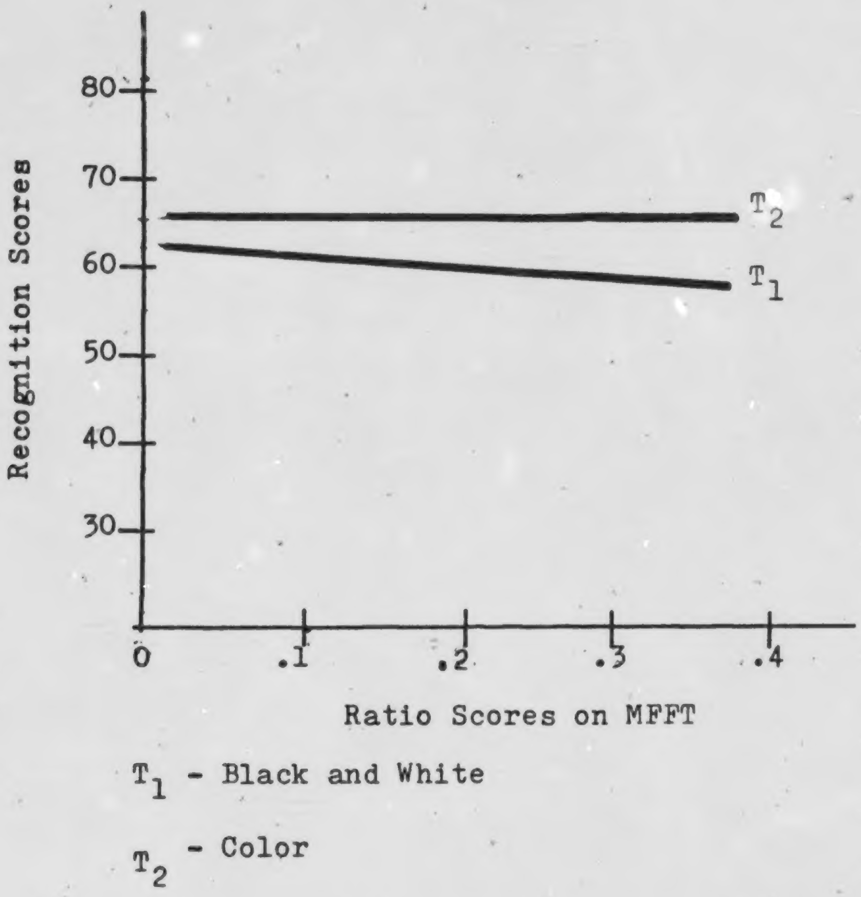
Linear Regression Equations - MFFT

Treatment	Intercept	Slope
Color	65.287	-8.923
Black and White	62.642	-28.436

The slopes for the two regression lines were tested by an F statistic and found not to be significant ($F = 1.795$; $df = 1/51$; $p < .01$). Therefore, Hypothesis 2 was retained. The slopes of the prediction lines for reflectivity-impulsivity and the two color modes were not significantly different. Thus, an interaction did not exist between the aptitude variable of reflectivity-impulsivity and the design element of color.

Even though no interaction existed between the two variables the regression lines were plotted in order to provide information leading to the generation of new hypotheses. The results of this operation are shown in Figure 2.

Figure 2. Regression Lines for MFFT and Treatment Mode



As seen in Figure 2, the two lines did not intersect within the range of the aptitude variable. This indicated that when the cognitive style variable of reflectivity-impulsivity is considered it makes no difference whether the visuals in a pictorial recognition memory task are presented in color or in black and white.

Ho: 3. There is no significant difference between the slopes of the planes used to predict performance on color or black and white memory task from scores of field dependence-independence and reflectivity-impulsivity when considered simultaneously.

The hypothesis was tested by means of a multivariate multiple regression analysis. The intercept and the slopes for each regression plane are reported in Table 3.

Table 3

Multivariate Multiple Regression Equations

Treatment	Intercept	CEFT Coefficient	MFFT Coefficient
Color	53.857	.718	-7.095
Black and White	60.155	.156	-28.038

The slopes for the two regression planes were then tested by an F statistic and found to be significant (F = 5.869; df - 2/50; $p < .05$). Therefore, Hypothesis 3 was rejected. The slopes of the prediction planes for field dependence-independence, reflectivity-impulsivity, and treatment modes were not equal. An interaction did exist between the two aptitude variables and the two treatment modes when considered simultaneously.

Two univariate tests were then done to determine which of the two independent variables was responsible for the interaction. The equality of the slopes for field dependence-independence and color and black and white, given that the variable reflectivity-impulsivity was also in the equation, was tested by an F statistic. The same procedure was also followed to test the equality of the slopes for reflectivity-impulsivity given that the variable field dependence-independence was also in the equation.

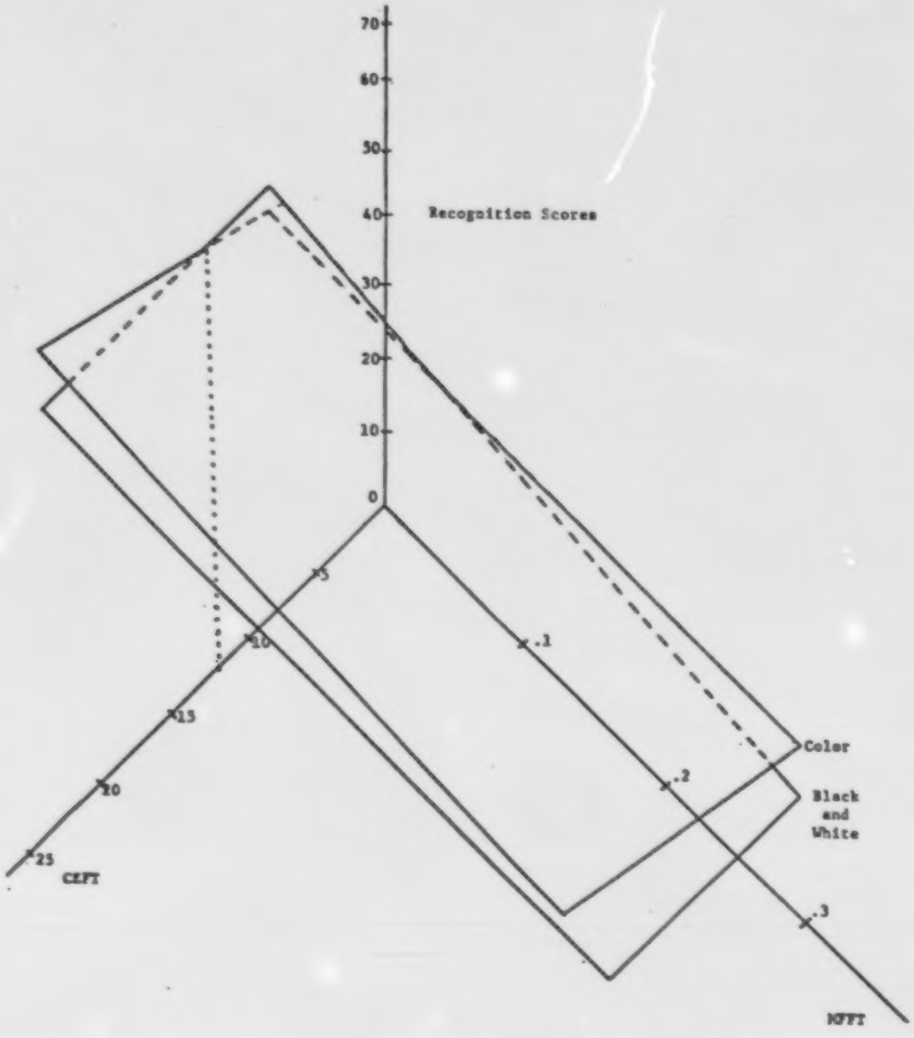
The results indicated that the interaction between the two aptitude variables and the two treatment variables was due to the presence of the field dependent-independent cognitive style. Reflectivity-impulsivity was not responsible for any of the interaction. The F value for field dependence-independence was 9.639 and for reflectivity-impulsivity 2.416.

These findings supported the results found in testing the two independent variables separately without regard for the presence of the other variable. In that case, a significant interaction was present for field dependence-independence and treatment mode as was the case when the two independent variables were considered simultaneously. Again reflectivity-impulsivity produced no interaction when considered independently or in conjunction with field dependence-independence.

The regression planes were then plotted to determine whether an ordinal or disordinal interaction existed. The results of this operation are shown in Figure 3.

As seen in Figure 3, a disordinal interaction existed with regression planes for color and for black and white intersecting within the range of the aptitude variables in question. Although both planes intersected a valid prediction line could not be drawn between the points of intersection because one interaction, that of MFFT, was not statistically significant. The point of intersection on the CEFT variable, however, was projected onto the CEFT axis. Subjects with scores below the intersection point on this axis benefited more from the use of the black and white treatment.

Figure 3. Regression Planes for MFFT, CEFT, and Treatment Mode



It must be pointed out, however, that in the case of reflectivity-impulsivity, either treatment was valid because a significant interaction did not exist between this variable and the treatment.

Discussion

The findings of the study indicated that since the slopes of the prediction lines for field dependence-independence and treatment mode were not equal a significant interaction did exist, in this case, a disordinal interaction. The point of intersection was a score of approximately 9 on the CEFT. Theoretically, all individuals to the right of the point of intersection, those with scores higher than 9, would benefit more from the color treatment, whereas those to the left of the point of intersection, those with scores less than 9, would benefit more from the black and white treatment.

Practically speaking, in the present study, only four individuals scored lower than 9 on the CEFT and at the present time statistical analysis capable of determining a justifiable decision rule for classification of individuals into treatment does not exist when one group has been given both treatments. It was possible, therefore, to determine that a significant interaction existed, but impossible to determine the points before and after the point of intersection where placement in one treatment or another would make a significant difference.

Since so few individuals scored below the point of intersection it can tentatively be concluded that the addition of color is a significant factor in a pictorial recognition memory task and may aid individuals along the entire continuum of field dependence-independence. This conclusion finds support in research done by Rudnick (1974) and Berry (1977), both of whom found color to be a significant variable in recognition memory. For the more field dependent individuals color may perform the task requirement of visual discrimination and separation--a process they are not able to accomplish themselves. For the more field independent individuals color may emphasize detail and contrast and enable these individuals to utilize more completely their ability to disembed figure from ground.

In order to test this conclusion it would be necessary to conduct research on groups of individuals that were given one treatment or the other so that a decision rule could be determined that would indicate at what points a significant difference would result if individuals were assigned to one treatment or another. It may be found that the significant cut off point for black and white does not lie within the range of the variable under consideration. At that time justification can be given for the use of color at any point on the scale of field dependence-independence.

It was also found that since the slopes of the predictions lines for reflectivity-impulsivity and color mode were not significantly different, an interaction did not exist. It is to be noted, however, that in all cases, color recognition scores were higher than those for black and white. The present results were somewhat unexpected because of the recent research by Katz (1971, 1972) and Chan (1974). Katz indicated that impulsive children respond to color more than reflective children, and in color-form sorting tasks impulsive children use color more often than do reflective children to accomplish the task. The results of the Chan study also indicated that on the MFFT, color stimuli facilitated learning when the intra-array similarity of each visual presentation was high.

In attempting to explain the lack of an interaction between this cognitive style and the treatment modes, a number of theories may be postulated. The first may be explained by reference to the two-stage model of selective attention suggested by Hagen (1972). The first stage is one of discrimination where the subject identifies both the relevant and incidental cues. The second stage involves focusing on the relevant features and ignoring the incidental cues. Impulsive children may have trouble attending selectively because of problems in stage 1 related to difficulty in distinguishing relevant from irrelevant cues. Since impulsive children are less analytic than reflective children and do better when required to perceive wholes rather than details, the addition of color may have resulted in the impulsive child being able to encode more visual cues. These children, however, may not be able to separate relevant from irrelevant cues and thus remember more pictures.

Another theory that can be considered centers around the area of response latency. Research by Fleming and Sheikhian (1972) has shown that presentation times of two seconds or less may be inadequate for processing the quantity of information available in pictures. In addition, Dwyer (1972) speculates that in fixed-pace presentations learners do not have time to take advantage of the added information available in realistic visuals, of which color is an example. In the present study the presentation time of 2 seconds may not have allowed the subjects to respond to the presence or absence of color in the visuals. In order to test this hypothesis it would be necessary to conduct a study which is self-paced, allowing learners to take as much time as necessary to scan each of the visuals. Since pictorial recognition is very high a ceiling effect can be avoided by increasing the similarity of each of the visuals.

Finally it was found that since the slopes for the prediction planes for both field dependence-independence and reflectivity-impulsivity, when tested simultaneously, were not equal an interaction existed, in this case a disordinal interaction. The results of further analysis indicated that the interaction between the bivariate aptitude and the two treatments was due to the presence of the field dependent-independent cognitive style. The point of interaction on the CEFT variable was projected onto the CEFT axis and was determined to be approximately 12. This intersection point differs from the previous one because the variable reflectivity-impulsivity was also in the regression equation. Thus, individuals with scores lower than 12 on the CEFT benefited more from a black and white treatment, whereas, individuals with scores higher than 12 benefited more from a color treatment.

It is interesting to note that even when the two cognitive styles are considered simultaneously, the interaction between treatment mode and cognitive style still raises the question as to whether color might not be effective for individuals along the entire continuum of field dependence-independence. Further research is again needed to clarify this issue. At the present time the color cueing appears to follow a perferential function. The addition of color to the visuals seemed to emphasize detail and contrast, thus enabling more field independent individuals to more fully utilize their ability to disembed figure from ground. The black and white color mode seemed to aid the more field dependent individuals by providing less visual cues and enabling them to encode and retrieve only those that were relevant. Knowlton's (1964) conclusion that realistic pictures, of which color is an element, are often too rich in detail and may act to reduce fidelity of communication by providing the viewer with cues that are irrelevant, may lend credence to this theory. Following Broadbent's (1958) and Travers' (1970) information overload hypothesis, the additional color cues may have jammed the information processing system of the more field dependent individuals, thus preventing the successful encoding and eventual retrieval of the color visual. Since, however, the black and white visuals did not offer as much detail and contrast, they could be more globally viewed and jamming would not occur. Only further research in which one or the other treatment is given to two individual groups can substantiate or refute this theory.

Summary and Conclusions

The present study clearly indicated that an interaction existed between color mode and field dependence-independence in a pictorial recognition memory task. It also concluded that such an interaction did not exist between color mode and reflectivity-impulsivity. When the two cognitive styles were considered simultaneously, an interaction was present, again caused by the variable of field dependence-independence. These results can offer a beginning for the construction of a matrix of learner characteristics, media attributes, and task variables. In this way media producers and educators would have clear cut guidelines for delineating the most effective media treatment to employ in order to optimize both instructional development and learning success. As the educational process moves towards the universal use of Individual Educational Prescriptions, a widely accepted practice in special education programs, these types of guidelines could prove to be invaluable. By determining each individual's cognitive profile the proper combination of media treatments can be prescribed so that a learning goal can be successfully achieved. Continuing research that clarifies the relationship of cognitive and non-cognitive variables with specific media attributes for specific learning goals will hopefully provide a widely accepted and utilized theory of instruction and a rebutal of the criticisms lodged against media research.

Recommendations for Further Research

In order to more fully understand the relationship of media design elements and cognitive styles, the following recommendations for further research are made:

1. This study should be replicated to confirm the present findings.

2. The present study should be replicated placing subjects in either of the two treatment groups. In this way a decision rule can be formulated that would indicate at what points a significant difference would result if individuals were assigned to one treatment or another.
3. Numerous cognitive styles have been identified, many of them related to visual perception. Research should be conducted to determine the interaction of these cognitive styles and color cueing.
4. The various cognitive styles related to visual perception should be investigated in relationship to other specific components of visuals i.e., realism, complexity, informational load, and non-realistic color.
5. The various cognitive styles and the various components of visuals should be investigated in relationship to different types of learning tasks, such as recall, rule learning, concept attainment and application.
6. This same type of interactive research must also be conducted to investigate the relationship of cognitive style and design elements with learning goals in the affective domain.
7. Conclusions in the present study were drawn concerning only a small portion of the population involved in learning tasks. Further research is needed to determine the interaction of cognitive style and design elements along a developmental scale.

8. The present study involved an investigation of immediate recall. Research should be conducted to determine the relationship of cognitive style and design elements using both immediate and delayed posttests.

9. The recognition task in the present study was externally paced. A similar investigation should be undertaken using a self-paced recognition task.

10. Research must also be conducted to determine the effects of intercultural differences on the interaction of cognitive styles and color cueing.

Adams, J.A. Learning and memory: an introduction. Homewood, Illinois: Dorsey Press, 1976.

Allen, W.H. Instructional media research: past, present, and future. AV Communication Review, 1971, 19, 5-18.

Berry, L.H. An exploratory study of the relative effectiveness of realistic and non-realistic color in visual instructional materials.

Berry, L.H. The effects of color realism on pictorial recognition memory. Paper presented at the Association for Educational Communications and Technology Convention, Miami Beach, Florida, April, 1977.

Broadbent, D.E. Perception and communication. London: Pergamon, 1958.

Chan, G.O. The effects of color stimuli on impulsive and reflective children'ts performance on visual discrimination tasks of different difficulty levels. Unpublished doctoral dissertation, Indiana University, 1974.

Cronbach, L.J. & Snow, R.E. Aptitude and instructional methods. New York: Irvington, 1977.

Dale, E. Audio-visual methods in teaching. (3rd ed.). New York: Dryden, 1969.

Drake, D.M. Perceptual correlates of impulsive and reflective behavior. Developmental Psychology, 1970, 2, 202-214.

Dwyer, F.M. Color as an instructional variable. AV Communication Review, 1971, 19, 399-416.

Egeland, B. Training impulsive children in the use of more efficient scanning techniques. Child Development, 1974, 45, 165-171.

Fleming, M.L. & Sheikhian, M. Influence of pictorial attributes on recognition memory. AV Communication Review, 1972, 20, 423-441.

Fullerton, B.J. The comparative effects of color and black and white guidance films employed with and without anticipatory remarks upon acquisition and retention of factual information. Dissertation Abstracts, 1956, 16, 1413.

Gropper, C.L. Learning from visuals: some behavioral considerations. AV Communication Review, 1966, 14, 37-66.

Hagen, J.W. Strategies for remembering. In S. Farnham-Diggory (Ed.), Information processing in children. New York: Academic Press, 1972.

Kagan, J. Matching familiar figures test. Cambridge: J. Kagan, 1969.

Kagan, J., Rosman, B.L., Day, D., Albert, J., & Phillips, W. Information processing in the child: significance of analytic and reflective attitudes. Psychological Monographs, 1964, 78, (1, Whole No. 578).

Kanner, J.H. & Rosenstein, A.J. Television in army training: color versus black and white. AV Communication Review, 1960, 8, 234-252.

Karp, S.A. & Konstadt, N. The children's embedded figures test. Palo Alto, Cal.: Consulting Psychologists Press, 1971.

Katz, M. Reflection-impulsivity and color-form sorting. Child Development, 1971, 42, 745-754.

Katz, M. Cognitive tempo and discrimination skill on color-form sorting tasks. Perceptual and Motor Skills, 1972, 35, 359-362.

Kerlinger, F.M. & Pedhauser, E.J. Multiple regression in behaviorial research. New York: Holt, Rinehart, & Winston, 1973.

Knowlton, J.Q. A socio-and-psycho-linguistic theory of pictorial communication. Bloomington, Indiana: Indiana University Division of Instructional Systems Technology, 1964.

Kogan, N. Educational implications of cognitive styles. In G.S. Lesser Psychology and educational practice. Glenview, Illinois: Scott, Foresman, 1971.

Myatt, B. The interaction of cognitive style and pictorial attributes in recognition memory tasks. Unpublished doctoral dissertation, University of Georgia, 1974.

Rudnick, M.F. The attention-getting effects of color and monochrome photographs on sixth grade students with differing perceptual styles. Unpublished doctoral dissertation, Indiana University, 1974.

Salomon, G. What does it do to Johnny? A cognitive-functional view of research on media. Viewpoints, 1971, 46, 33-61.

Salomon, G. & Clark, R.E. Reexamining the methodology of research on media and technology in education. Review of Educational Research, 1977, 47, 99-120.

Shepard, R. Recognition memory for words, sentences, and pictures. *Journal of Verbal Learning and Verbal Behavior*, 1967, *6*, 156-163.

Siegel, A.W., Kirasic, K.C., & Kilburg, R.B. Recognition memory in reflective and impulsive pre-school children. *Child Development*, 1973, *44*, 651-656.

Standing, L. Learning 10,000 pictures. *Quarterly Journal of Experimental Psychology*, 1973, *25*, 207-222.

Standing, L., Conezio, J., Haber, R.N. Perception and memory for pictures: single trial learning of 2500 visual stimuli. *Psychonomic Science*, 1970, *19*, 73-74.

Travers, R.M.W. *Man's information system*. Scranton, Pa.: Chandler, 1970.

VanderMeer, A.W. Color versus black and white in instructional films. *Audio-visual Communication Review*, 1954, *2*, 121-134.

Witkin, H.A., Dyk, R.B., Faterson, H.F., Goodenough, D.R., & Karp, S.A. *Psychological Differentiation* (Rev. Ed.). New York: John Wiley, 1974.

Witkin, H.A., Moore, C.A., Goodenough, D.R., & Cox, P.W. Field dependent and field independent cognitive styles and their educational implications, *Review of Educational Research*, 1977, *47*, 1-64.

Witkin, H.A., Oltman, P.K., Raskin, E., & Karp, S.A. *Manual: EFT, CEFT, GEFT*. Palo Alto, Cal.; Consulting Psychologists Press, 1971.

TITLE: Matching Learning Theory, Instructional Technology, and Evaluation Design

AUTHORS: Terry M. Wildman

John K. Burton

Matching Learning Theory. Instructional Technology, and Evaluation Design

(Paper presented at the 1980 AECT National Convention, Denver, Colorado, April 24, 1980)

Terry M. Wildman

and

John K. Burton

Virginia Polytechnic Institute and State University
Blacksburg, Virginia

For further information:

Terry M. Wildman
310 War Memorial Gym
College of Education
Virginia Polytechnic Institute
and State University
Blacksburg, VA 24061

Matching Learning Theory, Instructional Technology, and Evaluation Design

This paper comments on the state of educational evaluation and is directed both to those who produce and to those who consume evaluation data. At a surface level educational evaluators (the producers) may reasonably begin the new decade with feelings of optimism and permanency because some form of evaluation is now required in almost every type of educational endeavor supported by public funds. In addition educational systems are under pressure to change. Issues such as "mainstreaming" multicultural education, increased community involvement in the educational process, and preparing children to meet mandated minimum competency standards are but a few of the challenges which policy makers face as the decade opens.

As the need for policy decisions continues to increase in number and urgency, so will the need for information on which to base those decisions. Moreover, policy makers often protect themselves through the redundency of several levels of evaluation. Evaluators can expect to be busy in the 80's.

This positive projection notwithstanding, evaluators and consumers should also be concerned about the directions each will take in the 80's. The first part of this paper suggests that certain prevelant evaluation practices are seriously out of step with, and inappropriate for, current mainstream instructional activity in this country. Moreover, since educational practice is not a static exercise, conceptual advances currently in the literature will continue to force changes in instructional practice and exacerbate further the existing asynchrony with evaluation practice. The sections which follow describe the problems, propose a solution framework, and suggest an analysis of who should contribute what in future interactions between educators (teachers) and evaluators.

Signs and Dimensions of Asynchrony

Limited observations and limited variables

Evaluation of instruction has often been conducted as if it were possible to rush in, take a snap-shot of ongoing activity, and present this as evidence for making important decisions about a program. In this manner evaluation has "grown-up" more as an appendage to instruction than as an integral part of program development and operation. Even the more advanced two slice approach, featuring a *pre-program* slice and a *postprogram* slice, does not substantially improve this situation. One or two shot evaluations are problematic for several reasons. First, the approach fails to recognize that successful instruction is a continuous process and that many slices are necessary to be confident of its speed, direction and quality. Secondly, the slices are most often taken at the wrong time. During developmental stages instruction is "fluid" (Cronback, 1963) enough to benefit from corrective feedback whereas during full scale implementation it is highly unlikely that limited feedback will penetrate the more rigid structures. As appendages, evaluation components are very likely to be placed in these untimely positions. Finally, when one shot evaluations are planned it is necessary to select carefully the few variables to be observed or tested during a single visit, and this in turn creates two other major problems.

One outcome of the one shot evaluation approach is that it forces one to emphasize a very limited range of instructional variables (c.f. Scriven, 1972, 1975 & Stake 1976). Moreover, these variables are often examined in isolation with very little attention to interactions with each other, or with yet unnamed variables.

Figure 1 presents a model of current instructional design technology (Wildman, 1980) which makes explicit two important points: First, most instructional programs should be viewed as systems composed of many interacting components and second; evaluation as a process must deal singly and interactively with these various components. Note that evaluation is not simply a single component sandwiched between others all of which are arrayed in some linear fashion. Evaluation technology must be matched to the complexity of the system(s) it serves.

Is an evaluation theory or model enough?

When one examines the various components shown in Figure 1 it should be apparent that each represents a decision point in the design of instruction. It should also be apparent that decisions about learning outcomes, entry behaviors, sequencing, delivery systems, etc., can and do differ considerably across designers and also evaluators. One reasonable and systematic way in which designers and evaluators can reach different conclusions or decisions within components is to begin with competing views or theories of learning or for one or both parties to have no view at all. Selecting between inductive and deductive modes of learning, or between behavioral or information processing theories can for example, result in dramatically different kinds and sequences of instructional objectives, activities, and outcomes. When instructors and evaluators fail to agree upon a common learning framework for an evaluation study (or when an evaluator operates in a theoretical vacuum) it is possible for the two parties to view identical activities as having extraordinarily different values. The problem is that design and evaluation are areas which are appropriately technologies. As such they must be grounded in a common science; in common theory. When this does not occur it is analogous to solving a problem with newtonian physics and evaluating the solution with a relativistic orientation. The assumptions that the problem solver and evaluator make are not the same. This problem is not solved by authors (e.g. House, 1976) who, in a thorough and scholarly manner, investigate the underlying philosophies of evaluation models. Properly evaluation relies on the decision points specified by the operative design model in terms of when to collect data and the common theory to decide what kind of data is needed. Thus, to look at the philosophical assumptions of evaluation models is to look at the wrong "layer" or level. It is inappropriate to design an evaluation system, or to analyze that system, without looking at the thoery beneath; the theory of learning. In this regard, Scriven's (1976) concern with bias has led him to suggest that the evaluator "blindly" search for as many outcomes as possible with little or no communication with project designers. Without careful handling this approach representing the most radical, and potentially dangerous break of technology from its scientific underpinnings.

Lack of theoretical orientations about the nature of the learning process can cause other problems for evaluators as well. Later we will see that the attainment of competence is currently viewed as a deceptively complex process during which students naturally assume a great deal of responsibility for, and control over, their own behaviors. Evaluators who do not understand these more recent views of learning are poorly equipped to attach values to current teacher and student behaviors.

Shifting emphasis

It follows from each point mentioned above that we need to reverse the long standing emphasis on products in educational evaluation at the expense of directly studying and rewarding process improvements. (e.g. Stake, 1976) The competency testing movement in this country represents a prime example of the greater interest in describing what students can and cannot do instead of focusing on what conditions led to their experiencing success or failure.

This and other such movements gives educators little information on which to build a better process. It tends to lump each program into a huge trial and error process such that successful elements are often lost in a global "error" judgement.

Stake (1976) and Guba (1978) have attempted to overcome this problem with a shift toward process observations. Interestingly neither focus on the learning theory of the designer to guide their observations.

A related problem is that to date the major emphasis in evaluation has been on what is wrong with an educational program or activity. While it is understandable that such information may be useful in making certain required administrative or policy decisions (e.g., to fire a teacher, exclude a program, establish funding priorities, etc.), it is equally clear that an emphasis on negative results contributes relatively little to a positive climate of growth within and among educators. Teachers and instructional designers do achieve successes, and attention to replications of successful applications over time are needed to maintain confidence in one's professional abilities, and to build a better technology of instructional practice.

Improving Evaluation Technology

We have taken the time to point out certain general problem with evaluation practices because they are worth solving. They are worth solving because evaluation will become one of the most critical activities performed by educators in the coming decade. This prediction is made not in the context of previous uses of evaluation data (e.g., making policy or funding decisions), but because evaluation, as shown in Figure 1, should become the focal point for ongoing instructional development and improvement. For this to occur however it is necessary for shift evaluation from its long standing position as an appendage to one where it serves a control function. This will require a developmental effort in itself.

Promoting a common design framework

Evaluators and instructional planners, whether the same person with two hats or two persons (or teams) with separate responsibilities, must understand that instruction and evaluation are inseparable functions. This concept is demonstrated graphically in Figure 2, the expanded version of Figure 1.

The rationale for systems approaches to design of instruction is well known (see, for example, Dick & Carey, 1978; Gagne & Briggs, 1974; Glaser, 1966, 1976; Merrill & Tennyson, 1977; Wildman, Burton & Niles, 1979) and need not be detailed again in this paper. Essentially, these models or design frameworks serve the several functions of detailing major decision components, suggesting an optimum flow of design tasks, and reminding designers of possible interactive effects among components. While it may be true that most public school personnel as individuals have little direct experience with true systems approaches, these practices are already extensively utilized in military and industrial applications and are increasingly attractive within the public sector.

What is most interesting about Figure 2 then, is the extent to which evaluation takes a major role in monitoring and guiding the entire process. Within this context those evaluation models which focus (for example) only on describing program objectives and subsequently testing to see whether the objectives have been mastered are clearly very limited in terms of contributing to overall program development. Others are similarly limited but in different respects. In each case however, the major challenge lies in diverting usable and timely information to the program developer. We should concede perhaps that other constituencies (e.g., taxpayers, non-academic administrators, parents, etc.) may be satisfied with the more superficial evaluations which yield only summary statements about program outcomes.

A closer examination of Figure 2 is needed however, to understand the needs of our primary audience: the developers and implementers. As shown here, each of the six major components in the design sequence has a logical impact on the construction of the most complete evaluation system. Notice also that evaluation has not been given a temporal place in the model. Rather, we are suggesting that evaluation serve on ongoing "memory" function by accumulating information as the decisions within each components are made and checked (and rechecked) against decisions in previous components. However, deciding the kind of information to collect and the use to which it is put requires yet another major reorientation for evaluators.

Promoting theory based instructional evaluation

In addition to design considerations, instructional development (and hence evaluation) is also theory related. Each of the major theoretical positions of learning (e.g., behavioral, cognitive, humanistic, etc.) interacts with the various components in Figure 2 to produce somewhat different decisions -- sometimes quite different decisions. Consequently, generating a match between instruction and evaluation requires simultaneous consideration of at least two major parameters -- design parameters and theory parameters. As represented in Figure 2, the particular data needs or requirements listed under each component are generated by considering general technical concerns as well as the various specific information needs associated with a given theoretical orientation. A more detailed examination of these components will demonstrate further the manner in which instructional and evaluation activities are synchronized.

This concern with matching instruction and evaluation activities begins with the needs assessment and task analysis components. One key notion here that is frequently lacking in current evaluation methodology is that goals and objectives should not simply be accepted as presented, but should be examined in terms of the *quality of the processes* by which they were generated. The needs assessment process serves at least two critical functions. First, it ensures that program goals are continually updated and prioritized in terms of client needs. Secondly, these goal statements can be used as a standard for comparison to final program outcomes. The task analysis phase or component is more complex. The major purpose of this design component is to provide a detailed analysis of the information, attitudes, skills, and other requirements necessary to attain final learning outcomes. The technical details of performing task analyses are available elsewhere. The several implications for evaluation practice shown in Figure 2 however, should receive further mention. One of the basic objectives of task analysis is to make explicit the structure of to-be-learned content. Once this structure is known evaluators (and teachers) have several interesting options. First, objectives and accompanying evaluation items may be "copied" directly from the task structure. Secondly, if the task structure can display the information processing requirements it will greatly facilitate the development of devices for describing and assessing required student entry behaviors. Third, and most interesting, is the notion that task structures can be reproduced and used to graphically display student entry behavior and subsequent progress toward final learning outcomes. These graphic displays could show, over time, the cumulative development of student learning and could replace the standard lists of means, percentiles, and deviation scores which continue to confuse teachers and lie unused in school data systems. Presumably these displays could also be utilized in conjunction with the next component, analysis of student entry behaviors, to form an initial impression of the "distance" between students' existing cognitive structures (a critical concept in cognitive orientations to learning) and the "expert" structures created via the task analysis phase. Repeated comparisons of this sort provide a visible and instructionally relevant tracking of student learning.

Keeping track of student entry capabilities is of course an ongoing task. Aside from the attempts to detect cognitive structure characteristics, it is also clear that a great variety of additional information is needed to serve other conceptual approaches to the training of human behavior such as described in the theories of Skinner, Piaget, Bruner, Gagne, Ausubel, and others. A full listing of relevant evaluation concerns would exceed by far those shown in Figure 2. Nevertheless, evaluators should have the capability to shift data collection strategies in conjunction with theoretical shifts.

The remaining three components deal explicitly with the various major decisions regarding instructional delivery. As we move into these areas evaluators will need to exhibit the following general capabilities:

1) The ability to assess the technical quality of decisions and subsequent activities within each of these design areas.

2) The ability to understand the relationship between learning theory and decisions made within and among these components.

3) The ability to understand that decisions vary with (in addition to conceptual notions about learning) the previous decisions made across the first three components.

One promising development in terms of understanding the more specific evaluation requirements across all these components is the emergence of several theory-based teaching models such as those described by Weil and Joyce (1978). Such models have served to make visible the fact that, for example, the Concept Attainment Model based on Bruner's work requires substantially different information requirements than does the Advance Organizer Model based on Ausubel's work. Here is a case where two models from the same basic theoretical framework not only have different intended and incidental outcomes, but also require different kinds of student entry capabilities, are sequenced in opposite directions, involve different delivery systems and require substantially different learning activities. Even greater distinctions between data needs can be made when teaching models are generated from different theoretical frameworks. The challenge for evaluators, then, is to keep pace with these data demands which vary from model to model.

New Responsibilities

To remove these asynchronies which currently exist between teaching and evaluation activities both constituencies (i.e. teachers and evaluators) will have to engage in some rethinking concerning their responsibilities. Gains and losses will be experienced on both sides.

Teachers will gain in several important respects when ongoing and productive communication with evaluators is the rule. First, teachers should have a greater expectation that evaluators will play on their terms, that is, that they will generate evaluation questions and devices which will center around teachers' own theoretical and technical orientations. It should become a less frequent event that educators are unfairly subjected to the biases of evaluators who value only a limited range of instructional plans and activities simply because they do not correspond to historical patterns or do not produce outcomes amenable to standardized norm referenced testing procedures. Secondly, teachers should have increasing partnership in the conduct of evaluation studies which directly affect their professional lives.

These new partnerships however, carry with them some new responsibilities. Teachers will now be responsible for much of the documentation which goes into an evaluation study. Even in cases where independent evaluators are utilized, teachers may be required to submit information relative to the conceptual frameworks and/or models on which daily activities are based. Teachers will also need to provide details concerning program outcomes which may be different from those typically measured in large scale evaluations.

Evaluators will also experience certain benefits under more cooperative arrangements with instructional personnel. For one thing, they will have more information on which to generate evaluation plans and should also be able to expect a much higher level of documentation from teachers. Conducting an evaluation of instruction will become, as we have seen above, much more complex. Simple one and two slice evaluation models will have to be replaced by others more compatible with the newer instructional design and teaching models.

Administrators will benefit from having data to make decisions which is at once more fine grained and more related to the program designer's assumptions which were implicitly "bought" at the outset. This will also necessitate that administrators become more sophisticated consumers of theory. Finally educational researchers will benefit since evaluation would become research in a sense that the usual "traditional method" versus "whatever" never will.

The theory and technology is currently available to begin moving in these directions. What is needed now are school systems and professionals willing to begin moving toward these new relationships between evaluation and teaching.

References

Cronback, L.J. Course improvement through evaluation. *Teachers College Record*, 1963, *64* (8), 672-683.

Dick, W., and Carey, L.M. *The Systematic Design of Instruction*, Glenview, Ill.: Scott, Foresman and Co., 1978.

Gagne, R.M., and Briggs, L.J. *Principles of Instructional Design*, New York: Holt, Rinehart & Winston, Inc., 1974.

Glaser, R. The design of instruction. In J.I. Goodland (Ed.) *The Changing American School*, 65th Yearbook of the National Society for the Study of Education, Chicago: University of Chicago Press, 1966.

Glaser, R. Components of a psychology of instruction: toward a science of design. *Review of Educational Research*, 1976, *46*(1), pp. 1-24.

Guba, E.G. Toward a methodology of naturalistic enquiry in educational evaluation. (CSE monograph #8). Los Angeles: Center for the Study of Evaluation, UCLA Graduate School of Education, 1978.

Merrill, M.D., and Tennyson, R.D. *Teaching Concepts: An Instructional Design Guide*, Englewood Cliffs, N.J.: Educational Technology Publications, 1977.

Scriven, M. "Evaluation Bias and Its Control." In G.V. Glass (Ed.), *Evaluation Studies Review Annual*, Vol. 1 Beverly Hills, Calif.: Sage, 1976a.

Weil, M. and Joyce, B. *Information Processing Models of Teaching*, Englewood Cliffs: Prentice-Hall, Inc., 1978.

Wildman, T.M., Burton, J.K., and Niles, J.A. Integrating learning theory with the technology of instructional design. Paper presented at the annual meeting of the American Educational Research Association in San Francisco, April, 1979.

Wildman T.M. Instructional design as a framework for unifying curriculum. *Educational Technology*. In Press.

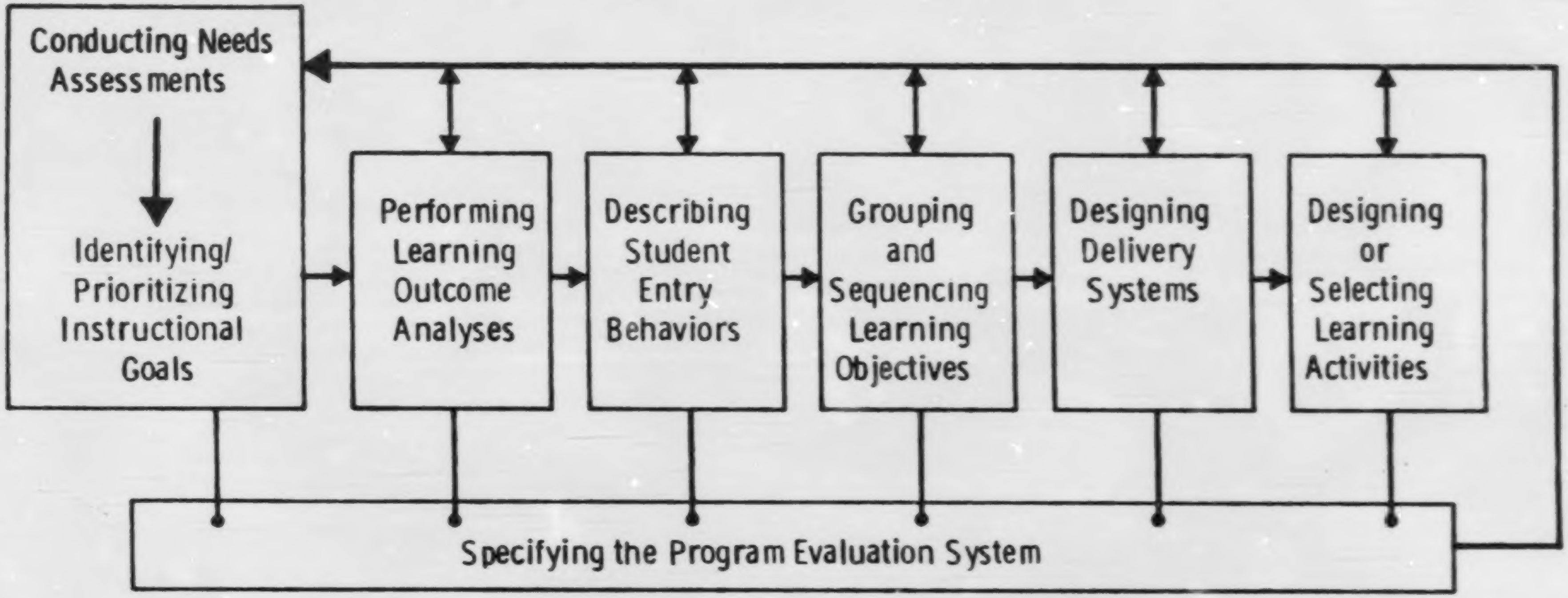
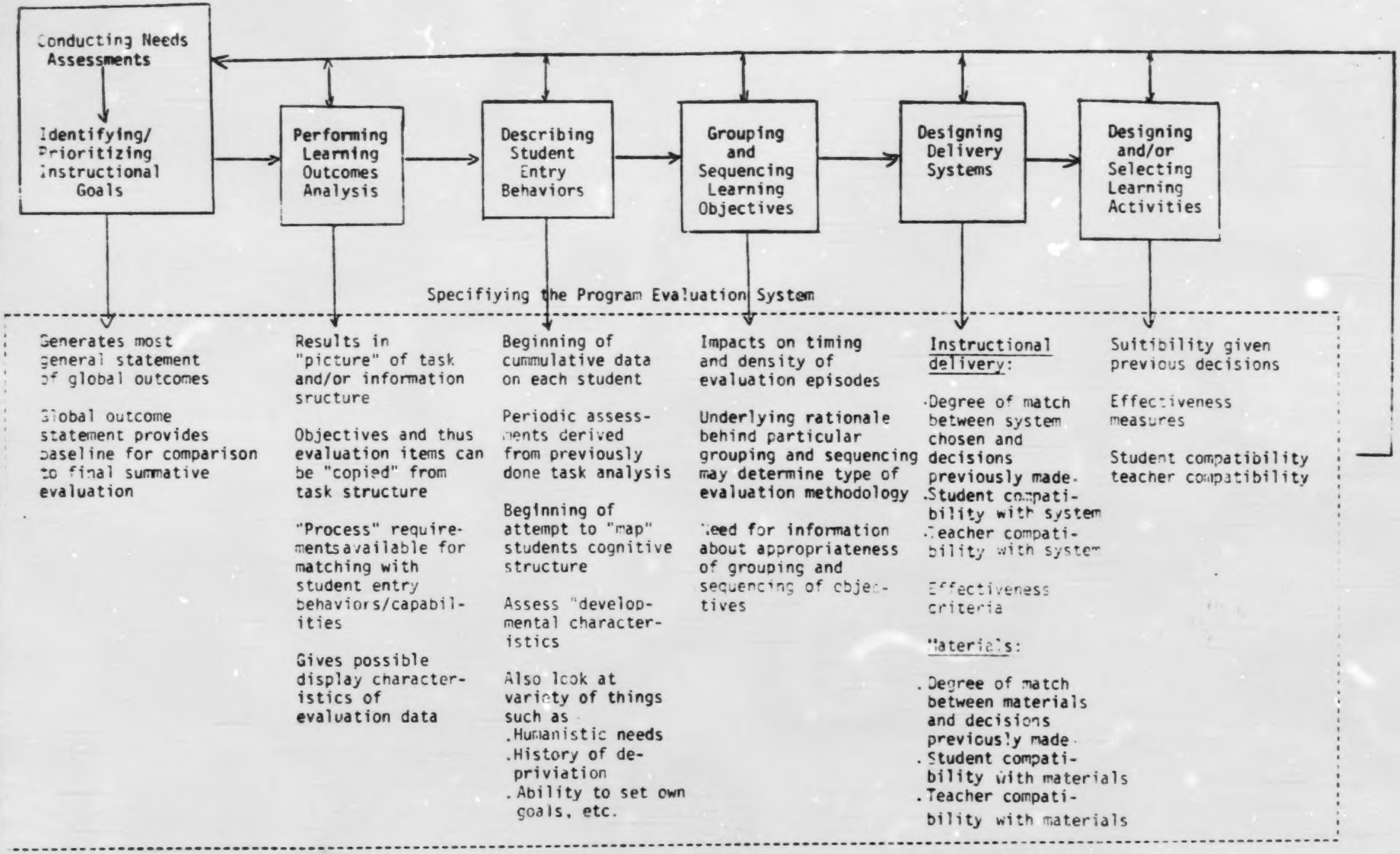

Conducting Needs Assessments
Identifying/ Prioritizing Instructional Goals
Performing Learning Outcome Analyses
Describing Student Entry Behaviors
Grouping and Sequencing Learning Objectives
Designing Delivery Systems
Designing or Selecting Learning Activities
Specifying the Program Evaluation System

Figure I. A Model for the Systematic Design of Instruction

(Note: This figure was used in another article by the author to be published by Educational Technology. Permission for use by the author is automatically granted)


Conducting Needs Assessments
Identifying/ Prioritizing Instructional Goals
Performing Learning Outcomes Analysis
Describing Student Entry Behaviors
Grouping and Sequencing Learning Objectives
Designing Delivery Systems
Designing and/or Selecting Learning Activities
Specifying the Program Evaluation System

Generates most general statement of global outcomes

Global outcome statement provides baseline for comparison to final summative evaluation

Results in "picture" of task and/or information sructure

Objectives and thus evaluation items can be "copied" from task structure

"Process" requirements available for matching with student entry behaviors/capabilities

Gives possible display characteristics of evaluation data

Beginning of cummulative data on each student

Periodic assessments derived from previously done task analysis

Beginning of attempt to "map" students cognitive structure

Assess "developmental characteristics

Also look at variety of things such as
.Humanistic needs
.History of depriviation
.Ability to set own goals, etc.

Impacts on timing and density of evaluation episodes

Underlying rationale behind particular grouping and sequencing may determine type of evaluation methodology

Need for information about appropriateness of grouping and sequencing of objectives

Instructional delivery:

- Degree of match between system chosen and decisions previously made.
- Student compatibility with system
- Teacher compatibility with system

Effectiveness criteria

Materials:

- Degree of match between materials and decisions previously made.
- Student compatibility with materials
- Teacher compatibility with materials

Suitibility given previous decisions

Effectiveness measures

Student compatibility teacher compatibility

Figure 2: A model specifying certain contributions of design components to program evaluation design.

TITLE: Information Processing and Visual Communication: Implications of Theory For Research

AUTHOR: William Winn

Information Processing and Visual Communication: Implications of Theory for Research

William Winn

University of Calgary

Presented at the Annual Convention of the
Association for Educational Communication
Technology, Denver, April, 1980.

This symposium has as its aim to explore three models of learning within which research in educational media can be conducted. Its particular focus is on research methodologies appropriate to each model. It is difficult, however, to discuss research methodologies without first examining the theories upon which they are based. For information processing, moreover, it is important to add an historical perspective as well, for the information-processing model of learning has evolved steadily over the last three decades, without the same degree of oscillation and polarization that has characterized the behavioral and the cognitive models. The characteristics of research in information processing, and the methods it uses, can be traced to mathematical-mechanical models of communication of the forties and fifties. Their evolution from descriptions of how, say, telephone systems communicate information to descriptions of human cognition has caused specifics to change. Yet the basic idea of information-processing -- that information changes the likelihood of particular behaviors or cognitive phenomena occuring -- remains unchanged.

The information-processing model of learning differs from the behavioral and the cognitive models. In the case of the behavioral model, the difference is one of substance. While the behavioral model describes learning in terms of certain stimuli causing certain responses, without too much concern for what happens in between, the information-processing model concerns itself more with the reasons why stimuli are related to responses. The same could be said about the cognitive model, which suggests that the difference between the information-processing model and the cognitive model is one of degree rather than substance. For the purpose of the following, it might be helpful to think of the information-processing model as a subset of the cognitive model. The particular approach taken by information-processing researchers to human learning and cognition focuses on the way in which information changes the way in which concepts are organized. The cognitive model is much broader.

This paper traces research in conceptual organization to its beginnings in mathematical models of information processing. At the same time, a theoretical framework for research is built up, and the information-processing model of learning is described.

Studies illustrating information processing are discussed. Finally, research strategies for visual information processing are suggested.

The most familiar form that the mathematical model of information has taken is the one given to it by Shannon and Weaver (1949). In addition to describing information flow from source to encoder, to channel, to decoder and to receiver, they developed the notion of the bit as a unit of information measurement. A bit is defined as the amount of information needed to reduce the number of alternatives by one half. For example, in a two-level hierarchy used to classify cats, dogs, snakes and lizards as mammals or reptiles, one bit of information would enable a person to classify an animal as either a mammal or a reptile, and a further bit would enable classification in one of the two sub-categories within the broader known category. On the other hand, knowing that a particular animal is not a dog would only eliminate one of the four alternatives. (Knowing that it is not a reptile would, of course, eliminate two.)

The limitations when applying this particular aspect of information theory directly to human communication were pointed out most clearly by Miller (1963).

> "Most of the careless claims for the importance of information theory arise from overly free associations to the word

> 'information'. This term occurs in the theory in a careful and particular way. It is not synonymous with 'meaning'. Only the amount of information is measured -- the amount does not specify the content, value, truthfulness, exclusiveness, history or purpose of the information."

The bit may be a useful unit for the telecommunications engineer. But for the psychologist, its exclusively quantitative nature limits its usefulness because it cannot permit the measurement of those things in which the psychologist is primarily interested. However, at a less specific level, the idea of information reducing the number of alternative outcomes to a particular event by half, or, if you will, increasing the probability of a particular behavior occuring after a given stimulus, has a central place in learning theory. It is this thread that can be traced from the early attempts to quantify information for engineers, right up to the present.

In the early sixties, several researchers tried to adapt this basic tenet of information theory to psychology, and to relate information to meaning. Garner (1962) suggested a two-step process to achieve this. The first step was to extend information theory so that the probability of a certain outcome occuring would be predicted from the combined probabilities of many pieces of information, rather than just one. The second step, following closely from the first, was to develop the notion of information as structure.

In the first instance, Garner suggested that since the human being is extremely complex psychologically, the notion of a single bit of information reducing uncertainty by one half is just not adequate to describe learning. For Garner, uncertainty in a learner can be ascribed to many sources at once, and can act, moreover, on many aspects of the learner simultaneously. As a result, the uncertainty of a given outcome must be attributed to many things. For Garner, this leads to bivariate, and multivariate uncertainty.

For example, if a learner is to classify a square, a rectangle, an equilateral triangle, and an isoceles triangle into two categories, it can be done in many ways. In the case of univariate uncertainty, the figures would be classifiable by one feature only, for example by the number of sides. In this case, if the learner knew that a certain figure were not three sided, he would be able to reduce the number of alternatives by half, and would have acquired one bit of information. However, learning is rarely that simple. If the figures also varied in size, they could be classified as large or small, as well as three or four-sided. This is an example of bivariate uncertainty, where the number of alternatives would not necessarily be reduced by half if the same amount of information were given. Were the figures also to vary in color, weight, the material from which they were made, and so on, the certainty with which one could predict the way in which they would be classified would be greatly reduced. This, obviously, is an example of multivariate uncertainty.

Given the fact that uncertainty has many sources in human learning, Garner went on to relate information to meaning. He achieved this by distinguishing between meaning as signification, and meaning as structure. Signification is defined as "the particular specifying or indicating relation for any single event or symbol"(1962, p. 141). In a way analogous to univariate uncertainty, if a learner knows what one event is, the other related event can be predicted with certainty. There is no ambiguity. Meaning as structure is defined as "the totality of relations between events" (1962, pp. 142-143). Since meaning is in this case affected by relationships among many events, the certainty of outcomes is far less predictable. We are dealing with multivariate uncertainty. The differences between signification and structure can be illustrated by reference to learning a foreign language. We learn significations when we learn the meanings of words, one to one. We learn structure when we learn the grammar and the idioms of the foreign language. Learning that French "chien" means English "dog" is not particularly useful unless the speaker can use the foreign word in meaningful sentences in combination with other words, and knows that calling a Frenchman a "son of a bitch" does not have the same effect as it would upon an English speaker.

Defining meaning as structure in this way makes information theory much more useful to the learning researcher. It allows the quantification of meaning in terms of the probability of a concept being associated with any of a number of other concepts. It also leads to the study of the way in which learners organize ideas. Instead of simply saying that a learner knows that "chien" means "dog", or that he does not, we can say that the learner is not sure that it means "dog", and thinks it could mean "cat" or "chair". And we can assign estimates of probability to these alternatives. The learner could be 75% sure it means "dog", 15% sure it means "cat" and 10% sure it means "chair". Put another way, we could say that the concept "chien", for the particular learner, is made up of 75% "dogness", 15% "catness" and 10% "chairness". Instructing the learner will alter these probabilities, by supplying information in such a way that the qualities of cats and chairs are suppressed, and "dogness" approaches 100% of the meaning of the concept.

Research into meaning as structure has taken many forms. However, researchers have frequently used word association in order to estimate the relationships among concepts, that is, the probability that one concept will solicit another. Deese (1962, 1965) studied the patterns formed by free word associations to sets of words that were themselves conceptually related. Subjects made free associations to words associated with "Spring".

For each possible pair of words, the number of common associations was counted and expressed as a proportion of the total number of responses. This produced a number between 0 and 1 which gave an estimate of the relatedness of each word in each pair, Deese's "relatedness coefficient". If the coefficients for all pairs are placed in a matrix, then it becomes apparent that patterns are formed by the interrelationships of words in the set. For example, in Deese's study, "insect", "bug", "fly" and "butterfly", had relatively high relatedness coefficients with each other. Other clusters also occured. In this way, the structure of the conceptual domain "Spring" became apparent through the amount of associative meaning shared by pairs of words within it.

The word-association technique has some interesting theoretical implications for research in information-processing. It suggests that the meaning of a word or picture can be defined in terms of the meaning it has in common with other words or pictures. For example, if the relatedness coefficients between cat and other animals are the following: "dog" .4, "lion" .3 and "porcupine" .1, then the meaning of "cat" can be said to have 40% in common with the meaning of "dog", 30% in common with "lion" and 10% in common with "porcupine". The remaining 20% is meaning unique to "cat". Furthermore, the overlapping of concepts that this implies means that the reduction of alternatives by giving information is by no means straightforward. For meaning to become clarified, it is necessary for a learner to be given information that allows specific discriminations to be made between concepts, not just a crude subdivision of the conceptual domain into halves.

It is the need for information that permits discrimination that leads to the next step in our consideration of information processing.

Olson (1970) defined information as "any perceptual or linguistic cue that reduces the number of alternatives to the intended referent". The notion of uncertainty reduction is still present in this definition; and two new elements have been added. The first of these is the idea of perceptual or verbal cues. The second is the idea that a communicator intends a message to refer to something specific. The first brings information theory into the media camp, for we are, by profession, purveyors of verbal and perceptual cues. The second relates information theory to learning, for it suggests that the giving of information, as perceptual and verbal cues, allows the consumer of that information to narrow down, through discrimination, what it was that the giver of the information meant. Taken together, these two notions lead to a consideration of how information is processed, for there is an implication that different verbal and perceptual cues will be effective in different ways in the reduction of alternatives to referents.

Word association has been used to study the way in which perceptual and verbal cues reduce the number of alternatives to intended referents. Shavelson (1972) instructed subjects in Newtonian mechanics over a period of several days, and administered word-association tests before, and at various points during the instruction. When the matrices of relatedness coefficients, calculated for all pairs of words naming concepts to do with mechanics, were compared to a matrix of coefficients representing the "intended" structure, derived by digraph analysis (Harary, Norman and Cartwright, 1965), it was found that instruction caused the way in which learners structured the domain to become increasingly similar to the intended structure. At the outset, the amount of meaning shared by the concepts, and the probability that one would elicit another, were minimal.

However, instruction, largely through verbal cues, reduced this uncertainty significantly. Winn (1980a, in press), conducted a similar study, where verbal and perceptual cues were provided. Instruction in food chains consisted of text plus a diagram in which the relationships among animals in a food chain were presented in terms of the distances between them. In the sequence "hawks eat snakes eat mice eat plants", hawks are "further from" mice than they are from snakes, and appeared further from them in the diagram. Again, it was found that instruction brought about an increase in the similarity between martices derived from word associations and a matrix representing the intended structure.

These two studies show that information, presented in verbal or perceptual forms, reduces learner uncertainty about what the content to be learned intends to communicate. They also suggest that the key to information processing lies in the way in which learners organize concepts. Information processing involves the perception, organization, storage and retrieval of concepts. Of these, organization is the key. Conceptual organization determines how we perceive, and how we remember. In its turn, conceptual organization is determined by perception and memory. What we know influences what we see; what we see influences what we know.

Current theory proposes that concepts are organized by one or both of two cognitive systems, the visual-spatial and the verbal-sequential, (Fleming, 1977; Kosslyn and Pomerantz; 1977; Anderson, 1978). The dual-code theory of processing and memory (Paivio, 1971, 1974) suggests that, although these two systems are interrelated, information received as verbal cues tends to activate the verbal system, and information in imaginal form is processed by the visual system. The organization of concepts in spatial images or in word-like strings is therefore determined largely by the form in which information is perceived. Other factors, such as learner aptitudes and the use to which learners expect to put the information have been discussed elsewhere (Salomon, 1979; Winn, 1980b, in press).

The visual-spatial information processing system works by organizing concepts in meaningful visual images. For example, Simon (1972) reports that the learning of noun paired-associates is improved if the learner is instructed to create a mental image incorporating both elements of the pair. It is easier to recall "cigar" as an associate to "whale" if the learner creates an image of a whale smoking a cigar. In this case, the creation of an image increases the probability of the correct associate being given to the stimulus word during the recall trial. It contains more information. Likewise, in some circumstances, the additional information provided by the abundant perceptual cues in pictures increases the probability that pictures will be more accurately recalled than words, and explains how paired associate tasks are made easier if the concepts are represented in pictorial form (Paivio and Csapo, 1973; Paivio and Yarmey, 1966).

The verbal-sequential system organizes concepts in linear fashion. A useful metaphor here is "semantic distance". In the food-chain study (Winn, 1980a) mentioned above, a diagram made explicit the distances between concepts in the predator-prey sequence -- a linear process. It was found that the diagram helped high-verbal students organize the concepts in a way that more closely resembled the intended structure than text alone. The fact that this difference was not found for low-verbal students supports the claim that learners with a more efficient verbal-sequential system gain more information from perceptual cues about sequences of concepts than do learners in whom this system is less efficient. In another study (Winn, 1980c, in press), it was found that a diagrammatic treatment helped high-verbal learners classify insects into superordinate categories (depending on the type of metamorphosis they undergo) more successfully than low verbal learners, providing further evidence for the relationship between verbal-sequential processing and concept organization. The probability of correct classification was increased for learners with an effective sequential processing system by providing cues about the semantic distance between concepts.

If information processing is considered to be the way in which concepts are perceived, organized, stored and retrieved, with organization largely determining the other three, then information processing must be studied within the context of the visual-spatial and verbal-sequential systems. The studies mentioned above, and countless others, have shown that relationships exist between the form in which information is presented (verbal or imaginal), the way in which concepts are organized, and the probability that the meaning that a learner derives from a communication will be the same as the intended meaning. The rest of this paper addresses the implications of this for the design of information-processing research studies. The discussion will be limited to research in visual information processing.

Research hypotheses

The first question that needs to be addressed is: what is it that research in visual information processing should study? From the previous discussion, three areas emerge for research. These are: structure and organization, processes and processing systems, and perceptual cues.

Hypotheses tested in information-processing research deal with the interrelationships among these three areas.

Information-processing researchers are particularly interested in the structure and organization of conceptual domains. Studies were described above in which the interrelationships among whole sets of concepts were described in terms of probabilities or relatedness coefficients. Information-processing research addresses questions about the changes in such conceptual organization as a result of information being given, rather than recall of information, trials to criterion, and so on. Researchers are interested in finding the most efficient ways of providing information that will change these structures so that intended learning takes place. They are interested in finding out the relationships between inter- and intra-subject meaning -- that is, the degree to which patterns of concepts are common among members of groups of subjects, or are unique to individuals.

Research in information processing seeks to discover more about the systems by which concepts are organized. This involves the study of perceptual, sensory and cognitive systems in the widest possible sense, ranging from the study of perceptual mechanisms, such as vision and hearing, to study of the spatial and sequential processing systems, even to neurological processing. Most familiar is research that seeks to discover more about how the verbal-sequential and the visual-spatial processing systems work. Typical of this research are studies in mental imagery. The research question here is: to what extent is visual information processed in picture-like images? Studies by Kosslyn (1973, 1975) on noticing details in pictures, and by Shepard (1978) on the rotation of letters, all suggest that visual information is processed in images, which can be scanned and manipulated in memory, just as real pictures can be. Fleming (1977), Anderson (1978) and Winn (1980b, in press) have addressed this issue in detail. Research has also shown that when learners are required to process visual information for purposes that do not require the scanning of images, such as in problem-solving of certain types, then information is processed as word-like propositions. Information-processing research seeks out relationships between the demands of the learning task and the system that processes the information. It also deals with learner aptitude and processing systems. This is because aptitude tests are often the best way of discovering the degree to which a particular processing system is developed in a learner.

Finally, information-processing research studies the role of various visual and verbal cues in helping learners to organize concepts (reduce uncertainty), and in activating the visual and verbal processing systems. Although visual cues tend to be processed by the visual system, and to give more information about visual concepts, with verbal cues serving the same purpose for the corresponding system and concepts, it is not always that straightforward. For instance, the question of translating information from verbal to visual and vice-versa is an important one for researchers to address, particularly since educators frequently defy the logic of expecting students to perform and be tested in the same medium as the one in which they were given information. (The possible role of propositional processing as a cognitive inter-lingua, serving to translate from imaginal to verbal forms has been discussed elsewhere. See Kosslyn and Pomerantz, 1977.)

Research hypotheses for information-processing studies will therefore make reference to relationships between organization and processes, organization and visual cues, and processes and visual cues. Examples might be: predicting that high-verbal subjects would structure a particular conceptual domain more effectively than low-verbal learners (structure-process); that concepts learned from pictures will be better organized than concepts learned from text (structure-cue); and that high-verbal learners would structure concepts learned from a diagram more correctly than those learned from a picture, the reverse being true for low-verbals (process-cue).

Dependent variables

Such phrases as "structure more effectively" and "better organized" require careful operational definition. Ways of empirically describing concept organization from word associations were described above. Other methods also exist, such as the construction of tree diagrams by learners (Waern, 1972). Whatever the method, the dependent variable will appear as a pattern of numbers which indicate the interrelationships among concepts. However, such patterns are insufficient in themselves for hypothesis testing. Research almost always requires the comparison of scores across treatments or across trials. The question arises: how does one compare matrices of relatedness coefficients across groups? Before statistical tests, such as analysis of variance or multiple regression, can be performed, concept patterns have to be expressed in simpler form. A way of doing this is to compare each subject's matrix to a standard, "correct", matrix, in order to determine how similar they are. Research hypotheses about structure then become statements of the similarity of subjects' matrices to the standard, as a function of various treatments, predictors and so on. Differences between patterns of concepts and the "standard" pattern can be estimated by calculating euclidean distances between the matrices derived from learners' free associations and the standard matrix (Shavelson, 1972; League, 1977). This reduces each subject's matrix to a single score, which is a measure of the similarity of organization between the two matrices. This presupposes, of course, that the standard can be expressed in matrix form. However, if semantic distances between single concepts can be estimated, then a matrix of these can be created. One such method for doing this is digraph analysis (Harary, Norman and Cartwright, 1966).

Another, simpler, way of measuring organization is to give posttests requiring subjects to classify concepts they have learned into categories. If the classification scheme consists of several dimensions, and multiple categories, then concepts will indeed be closer to some and further from others. The pattern of concepts a subject has learned will emerge from the way in which they are classified. Dependent variables will therefore have to do with the accuracy of classification, based on as many or as few categories as the researcher wishes. Research hypotheses will be concerned with predicting correct classification scores as a function of various visual cues, learner aptitudes and so on.

Independent variables and predictors

The question now is: what is information-processing research interested in manipulating, and how? The answer is easiest to find for hypotheses that have to do with the effects of visual cues on concept organization. Obviously, visual cues have to be manipulated. However, it is important for this kind of research that such manipulation be more finely tuned than the typical picture-versus-word, or color-versus-black-and-white-picture study. Research in information processing must be concerned with the properties of various pictorial cues. For example, spatial arrangement within a visual is an important visual cue. However, little knowledge would be gained about information processing by comparing two treatments with and without spatial arrangement. It would be more useful, for example, to compare two different types of spatial arrangement, one of which stressed sequence of concepts, the other concept patterns. Should the former arrangement prove to be the most effective, than something could be concluded about how the information was processed. If the researcher also knew something about the structure of the content that was communicated to the learners, then conclusions about the appropriateness of sequential arrangement in visuals could be drawn.

If, in addition to their scores on the experimental task, the researcher was unable to distinguish between learners on the basis of their preferred, or most efficient, processing system (spatial or sequential), then even more information about spatial arrangement in visuals would be forthcoming. This suggests that ATI studies, in which spatial and verbal ability are used as predictors, are appropriate for the study of visual information processing. The various aptitude tests that are commonly available are probably the best way researchers have of determining which processing systems are likely to be activated in different learners. Of course, the predictions that can be made on the basis of aptitude scores will often be overriden if the content to be learned is better processed by another system, or if the learner has certain expectations about the use to which the information is to be put.

Information-processing studies have also manipulated instructions given to subjects with considerable success. The best examples of this are studies in paired-associate learning, where subjects have been instructed to form, and even to draw, associative images, to embed paired-associates into sentences, to use various other mnemonics, or simply to memorize (see, for example, Paivio and Foth, 1970). Instructions such as these cause information to be processed in certain ways, controlled by the experimenter. In a similar way, instructions could also encourage subjects to process concepts sequentially or spatially, and could even override the natural tendency of subjects to process certain types of information in specific ways. Instructions to subjects is a variable that has received insufficient attention by researchers in information processing.

Data analysis

Data from information-processing research can be analyzed in the usual ways. However, a word needs to be said about the analysis of concept structures. Information about relationships between concepts is complex and detailed. A way of distilling it, by calculating euclidean distances between matrices, was suggested above. However, other methods exist for making concept interrelationships, described in matrices, more amenable to interpretation. These are factor analysis and multidimensional scaling. Both of these techniques reduce complex systems of variables to a limited number of factors or dimensions, which represent the underlying structure. Deese (1965) used factor analysis to help him interpret the associative meaning of the concepts to do with "Spring". In this case, factor analysis identified clusters of concepts that seemed to belong together. Winn (1976) used simultaneous factor analysis in order to compare the underlying structure of associations made to words and to pictures. Shavelson (1972) used multidimensional scaling in order to help him interpret his data on cognitive structures formed for Newtonian mechanics. In each case, analysis simplified complex data, and revealed underlying structure.

A word should also be said about predictors in ATI studies. Since scores on many of the sub-tests in aptitude batteries are often correlated, it is not possible to interpret a significant interaction in terms of, say, the spatial or the verbal system. If verbal and spatial scores are correlated, then high-verbals will also tend to be high-spatial. It is therefore often necessary to partial out variance caused by aptitude scores in which the researcher is not interested, in order to "purify" the aptitude under investigation. It should be emphasized that this should be done when an aptitude score is to be interpreted as indicating something about an information-processing system. If an aptitude is defined operationally as the score a learner makes on a certain test, then partialling out variance in this way is not necessary.

The discussion of implications of information-processing theory for research studies has been limited to just a few of the hypotheses, variables and analysis procedures that are in fact of interest. This is inevitable, because human information processing is a vast and complex topic. However, the elements of research design that were mentioned have produced useful information about how people produce information, within the confines of conceptual organization. They are also likely to have application beyond this area. Undoubtedly, researchers will develop and adapt other techniques to their needs. It may even be more hindrance than help to try to distinguish between information processing and other types of research. They are all related, as this symposium will no doubt demonstrate. Hopefully, however, these few pointers will help other researchers unravel the complexities of how people process information.

References

Anderson, J.R. Arguments concerning representations for mental imagery. Psychological Review, 1978, 85, 249-277.

Deese, J. On the structure of associative meaning. Psychological Review, 1962, 69, 161-175.

Deese, J. The structure of associations in language and thought. Baltimore: Johns Hopkins Press, 1965.

Fleming, M.L. The picture in your mind. AV Communication Review, 1977, 25, 43-62.

Garner, W.R. Uncertainty and structure as psychological concepts. New York: Wiley, 1962.

Harary, F., Norman, R.Z., & Cartwright, D. Structural models: an introduction to the theory of directed graphs. New York: Wiley, 1965.

Kosslyn, S.M. Information representation in visual images. Cognitive Psychology, 1975, 7, 341-370.

Kosslyn, S.M. Scanning visual images: some structural implications. Perception and psychophysics, 1973, 14, 90-94.

Kosslyn, S.M., & Pomerantz, J.R. Imagery, propositions and the form of internal representations. Cognitive Psychology, 1977, 9, 52-76.

League, R. Psycholinguistic matrices. The Hague: Mouton, 1977.

Miller, G .A. What is information measurement? American Psychologist, 1953, 8, 3-12.

Olson, D.R. Language and thought: aspects of a cognitive theory of semantics. Psychological Review, 1970, 77, 257-273.

Paivio, A. Imagery and verbal processes. New York: Holt Rinehart and winston, 1971.

Paivio, A. Language and knowledge of the world. Educational Researcher, 1974, 3(9), 5-12.

Paivio, A, & Csapo, K. Picture superiority in free recall: imagery or dual coding. Cognitive Psychology, 1973, 5, 176-206.

Paivio, A., & Foth, D. Imaginal and verbal mediators and noun concreteness in paired-associate learning: the elusive interaction. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 384-390.

Paivio, A. & Yarmey, A.D. Pictures versus words as stimuli and responses in paired-associate learning. Psychonomic Science, 1966, 5, 235-236.

Salomon, G. Interaction of Media, Cognition and Learning. San Francisco: Jossey Bass, 1979.

Shannon, C.E., & Weaver, W. The mathematical theory of communication. Urbana: University of Illinois Press, 1949.

Shavelson, R.J. Some aspects of the correspondence between content structure and cognitive structure in physics instruction. Journal of Educational Psychology, 1972, 63, 225-234.

Shepard, R.N. The mental image. American Psychologist, 1978, 85, 125-137.